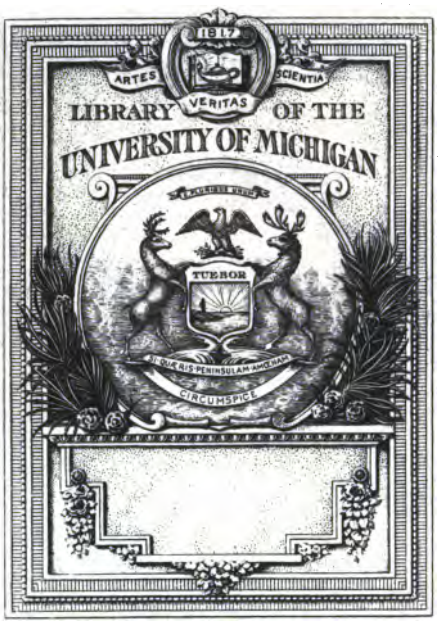
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Michigan. State inspector of salt.

(345)

STATISTICS

RELATING TO THE

SALINE INTERESTS OF MICHIGAN.

COMPILED BY

S. S. GARRIGUES, PH. D.,

STATE SALT INSPECTOR,

AND REPORTED BY THE

COMMITTEE ON LUMBER AND SALT.

BY AUTHORITY.

LANSING:
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1881.

SALT IN MICHIGAN.

HISTORICAL.

It was known from the earliest settlement of the country that the Indians formerly supplied themselves with salt from springs existing in this Peninsula, but the history of this product as developed by the white man begins with the report made by the State Geologist on the subject of brine springs, contained in the House documents of 1838. Dr. Houghton commenced this report by speaking of the importance of the question to the interests of the State, and says:

"Little or nothing of a definite character has hitherto been known respecting either the location or quality of these springs, and nothing of the geological circumstances under which they occur."

He then alludes to the fact that the Indians knew of these brine springs, and mentions several of them. He speaks of the one at the mouth of Salt river as follows:

"On the Tittabawassee river, in Midland county, numerous indications of the existence of brine springs were noticed, extending from near the mouth of Chippewa river as far as I ascended the former stream, being a few miles above the mouth of Salt river. Upon either side of the Tittabawassee river, between the points noted, small pools of brackish water were observed, as also, occasionally, springs discharging a similar water in small quantities; and although an examination showed the waters to contain large quantities of the salts of lime, and occasionally of iron, they were never destitute of more or less salt.

"Springs of a more decided character occur in the vicinity of the mouth of Salt river. The first observed occurs in the stream near the right bank of the Tittabawassee, a little below Salt river, and at the time of my visit was covered by some two to two and a-half feet of water.

"The spring was found by actual admeasurement to discharge about seventy gallons of water per hour.

"Nearly a mile above this spring, upon the same bank, and elevated from eight to ten feet above the water of the river, is a second spring, discharging a somewhat larger quantity of water.

"Near by, but at a greater elevation, several small springs of brackish waters were seen issuing from the sloping bank of the river, which upon examination were found to contain a notable quantity of salt.

"The quantity of water discharged from these springs is small, but when considered in connection with those already noticed, they become matters of considerable interest, since they serve to show that the salines are not confined to one or two springs, but are widely dispersed over a large district of country.

"Brine springs are known to exist near the mouths of Flint and Cass rivers, in Saginaw county, and also in Sanilac county, but as they occur in a flat section of country, the unfavorable season compelled me to defer examining them until some future time."

In accordance with the recommendation contained in the Governor's message, the Legislature, by act approved March 4, 1838, directed the State Geologist to commence boring for salt as soon as practicable, at one or more of the State salt springs; and authorized him to employ a chief assistant, well skilled in the practice of salt boring, and other assistants, as might be necessary, appropriating a sum not exceeding three thousand dollars to defray the expenses, to be paid out of the Internal Improvement Fund. The act also required the State Geologist to make report at the next regular session of the Legislature.

The report thus called for was made January 1, 1839. In this report the State Geologist informed us that, with a view to avail himself of the most recent improvements in the method of conducting the work, he visited the principal salt wells of Ohio, Pennsylvania, and Virginia. He says that the salt springs of New York are so differently situated that a satisfactory comparison with them can scarcely be instituted.

"Any attempt to improve the water of our own springs upon the plan there pursued, would most assuredly prove valueless."

"The brine springs of our State, like those of Ohio, Pennsylvania and Virginia, emanate from a rock which lies deep, being covered with a mass of rock and earthy matter, which it is necessary to penetrate. In this respect they differ most essentially from those of New York."

Referring to Ohio and Virginia, he says: "The salt rock lies at a considerable depth, and is overlaid by strata of sandstone, limestone, slate, etc., and through fissures in these overlying rocks the salt water, much diluted by the influx of fresh water, originally rose to the surface. In order to procure water of sufficient strength and purity, it has been found indispensable to penetrate the overlying rocks, as well as a portion of the rock from which the salt water flows. The depth to which it has been found necessary to sink varies from three hundred and fifty to one thousand feet, the deep borings, for the most part, furnishing water of a strength superior to the more superficial ones."

Two points were selected for test wells: one on the Grand river, about three miles below the village of Grand Rapids, and the other on the Tittabawassee river, in Midland county, at the mouth of Salt river. Up to the date of this report there had been expended at the works on Grand river $1,767.52, and at the works at the mouth of Salt river $2,118.67, thus exceeding the appropriation something over $800. This excess, with his estimate of a proper appropriation for the current year, he states at $12,350.

This report was referred in the Senate to the Committee on Manufactures, who reported that an act ought to be passed making an appropriation sufficient to enable the geological corps to progress with the improvements that have been commenced at Grand and Tittabawassee rivers, and to pursue them to a final result. They suggest that the reference to them of this subject indicates that the Senate fully anticipate the manufacture of salt and its transportation to its destined market, and therefore they have taken into consideration the saline district of the State, and are of opinion that the salt-bearing rock is principally in the northern part of the State, where the remainder of the salt springs will most probably be found.

The Legislature acted promptly on the recommendations, and by act of

January 28th, 1839, the State Geologist was directed to continue the improvements, and $15,000 was appropriated for the purpose of defraying the expenses.

At a little less than fifty feet a considerable vein of salt water was opened, but so intermixed with veins of fresh water as to make it impossible to determine the absolute quantity of saline matter contained in it.

The work was then reported as suspended, because the moneys appropriated could not be realized.

This report was referred to a select committee, of which Henry P. Bridge was chairman. In the report of this committee attention is called to the fact that seventy-two sections of land, amounting to more than forty-six thousand acres, which, apart from the special value in consequence of the salt springs, are richly worth $5 per acre, must be regarded as a gift from the United States, in consideration of the testing of their value for the production of salt.

"Your committee are fully of the opinion that the prospects of success offered by a continuance of the improvements in progress are such as not only to warrant their continuance, but also that the best interests of the State demand it."

The committee recommended an appropriation for that object of fourteen thousand dollars, which was believed to be sufficient to test the value of the springs.

The Legislature, by act of March 30, 1840, appropriated $5,000 for the improvements at the salt springs on Grand river, and $5,000 for those at the Tittabawassee river. Under this act contracts were made by the State Geologist, in December, 1840, with Lucius Lyon, to sink the well on Grand river to 300 feet from the surface, for the sum of $5,000, and with Ira T. Farrand, by which said Farrand agreed to sink the shaft upon the State salt lands at Tittabawassee to the rock beneath, and a well in said rock to the depth of three hundred feet from the surface, the price to be $17 per foot for the first 50 feet and $16 per running foot for the remaining 250 feet; and in addition the State to pay for the tubing, if any be used. These contracts were submitted to the Legislature by Gov. Woodbridge with a special message, January 9, 1841.

In the annual message of Gov. Barry, January 4, 1842, he says that there has been appropriated out of the Internal Improvement Fund for the improvement of the State salt springs the sum of $28,000, of which $20,134.32 has been expended, leaving an unexpended balance of $7,865.68. The attempt to obtain water possessing qualities suitable for making salt has thus far proved unsuccessful.

The report of the State Geologist of January 5, 1842, relative to State salt springs, says that under the joint resolution of March 16, 1841, the contracts referred to were duly confirmed, and the work, which for eighteen months had been resting, had been commenced. At the mouth of Salt river, where the earth-boring was originally estimated at one hundred to one hundred and fifty feet, after nine months of continuous labor the contractor had only been able to reach a depth of one hundred and thirty-nine feet. He restates the opinion that to obtain water of maximum strength the shaft on Grand river should be sunk to a depth of seven hundred feet, and on Tittabawassee river of at least six hundred feet, and renews the opinion that both the wells should be prosecuted to completion at an early day.

The Legislature, by act approved February 14, 1842, appropriated $15,000 to be expended upon the two wells already commenced.

By act of February 16, 1842, the Governor was authorized to cause the salt springs lands of the State to be platted into lots and to lease the right to manufacture salt, provided that every lease should contain a clause requiring

at least fourteen cents per bushel of fifty-six pounds to be paid to the State for the water.

The report of the State Geologist, dated January 23, 1843, shows considerable progress in the work on Grand river; but at the spring on the Tittabawassee river no farther progress had been made, and no disbursements except enough to keep the machinery in repair. The reason assigned for not going on with the work implies a doubt concerning the title of the State to the lands where the salt well was commenced.

The foregoing comprises, it is believed, the entire action of the State toward the development of the salt springs in the Saginaw Valley prior to 1859.

The names of the gentlemen to whom the State is indebted for the discovery of brine in Saginaw Valley, in paying quality and quantity, and at whose risk and expense this vast industry was first developed, are Wm. L. P. Little, Webber & Wheeler, James L. Ketcham, Geo. A. Lathrop, Dwight G. Holland, Moses B. Hess, Alexander English, John F. Driggs, Wm. J. Bartow, Wm. F. Glasby, Jesse Hoyt, Charles B. Mott, Henry C. Potter, Chester B. Jones and John Derby, who each took 120 shares. Wm. C. Yawkey and Geo. W. Merrill took each 40 shares in the first company formed. D. W. C. Gage and O. P. Burt took each 20 shares. C. H. Gage and Perry Joslin took each 10 shares, making up the two thousand shares of capital stock of the company.

Dr. Geo. A. Lathrop was chosen as president, W. L. P. Little as treasurer, and W. L. Webber as secretary, and these officers, with Messrs. Mott, Ketcham, Hess, Potter, Merrill and Glasby, made up the board of directors. Mr. Jesse Hoyt tendered the use of ten acres of land near the bank of the river, on the N. ½ of Section 18, T. 12 N., of R. 5 E. for the boring of an experimental well, with an option in case of success to purchase the same at an agreed price; and a committee, consisting of Geo. W. Merrill and Capt. Stephen R. Hirby, was appointed to visit the Onondaga salt wells and learn what buildings, machinery and tools were necessary for boring the well.

To properly appreciate the undertaking, it should be remembered that the gentlemen connected with this enterprise had no knowledge on the subject of the geological formation of the valley, and no one connected with the work had any experience or knowledge concerning the boring of wells of this character. They did know, however, that the State, under the direction of Dr. Houghton, had expended several thousand dollars at the mouth of the Salt river to reach a depth of 139 feet, and that the earth-boring was not concluded when that experiment was abandoned. Work was commenced, however, a drill-house erected, an engine procured, which was run under the direction of Sanford Keeler, the present superintendent of the Flint & Pere Marquette Railroad Company, other necessary tools made or purchased, tubing for the earth-boring was secured, and the well begun. The want of information to know what was to be done and how best to do it was such that what is now the work of sixty days was not completed until the 7th of February, 1860, nor until that date did the board of directors feel authorized to declare the experiment a success. They had been encouraged from time to time by the increased strength of the brine as the well was lowered from point to point; but they knew that until chemical analysis should show that the quality of the brine was such as could be profitably used for the manufacture of salt, it could not be deemed a success.

At the date last named the board made a report to the stockholders, a portion of which reads as follows:

"We have been aware of your natural anxiety for information during the

progress of the work, but the board of directors at an early day adopted the policy of studiously withholding the facts developed from time to time, however encouraging, lest they might excite hope which the final result would fail to satisfy. We are happy now to assure you that Saginaw possesses salt water second in strength and purity, and we believe in quantity, to none in the United States."

The following table shows the strength of the brine obtained from the first well, at various depths:

At	90	1 degree.
"	102	2 degrees.
"	211	10 "
"	212	14 "
"	487	26 "
"	516	40 "
"	531	44 "
"	559	60 "
"	569	64 "
"	606	86 "
"	636	90 "

The first salt was made in the Saginaw Valley under the superintendence of Dr. H. C. Potter, the present general manager of the Flint & Pere Marquette Railway. The well was bored by Sanford Keeler, Esq. Dr. Potter personally superintended the manufacture of the first 4,000 barrels of salt at the old East Saginaw salt works. On July 4th, 1860, the pioneer salt blocks of the East Saginaw Company were opened for inspection, and they were thronged all day from the Saginaws and adjacent places. Dennis and Tom Redmond, who have always been identified with the salt interest here, were engaged as boilers on that day.

GEOLOGICAL.

The group of rocks which form the lower Peninsula of Michigan, being like so many oblong saucers one within the other, depressed in the center of the State and outcropping at the edges, is known as follows: First, or lowest, the dolomitic limestones which are regarded as the Helderberg group of New York. These are the oldest strata, whose outcroppings are found in the lower Peninsula, and the lower portions are regarded as the bottom of some lagoon in the old Devonian Ocean, which in drying up has deposited its saline properties in the form of rock salt. The next two saucers represent the Hamilton and Black Shale groups, in which we are not at present interested. Above or within there is another group whose only outcroppings are found around Saginaw Bay and on the eastern shore of Lake Michigan. This is known as the Waverly group, and is formed of the salt-bearing sand rock, which is the source of the Saginaw brine. It is a sea shore rock. Prints of sea weeds are found in it, and sharks' teeth, some of enormous size, and also the remains of enormous reed trees, are found, testifying to the proximity of land. Hence we can infer that the waves of that Devonian Sea, whose rocky bottom was far below, here dashed against the shore and deposited their briny burden for our use.

Let us understand that the formation which gives the most valuable salt brines in Saginaw Valley is now named the Waverly group by Dr. Rominger, State Geologist, and consists of a series of sand stones and blue and red shales amounting to 1,000 to 1,200 feet in thickness. This formation commences at

the bottom of the gypsum formation and extends downward to the black shales as seen at Sulphur Island, Thunder Bay. Indications of solid rock salt have never been found in any of the salt wells of Saginaw Valley; but the outcrop of this Waverly group on the eastern shore of Lake Michigan is composed of sand drift, some 600 feet in thickness, which has long ago been deprived of its salt. Recent borings at Manistee, in the northwestern part of the State, passed through the 600 feet of sand, then into the soft shales of the Huron group, then into the limestones of the Hamilton group, and lastly of the Helderberg group, striking, at the distance of 1,950 feet from the surface, the rock salt of the old Devonian Ocean, and corresponding, in all probability, to the rock salt of Goderich. In making these borings, brines of various strengths were found at different depths, but all below a depth of 1,400 feet. A well has quite recently been projected at Cheboygan. This point being in the Helderberg formation, there are grounds for supposing that borings will develop the same results that have been obtained at Goderich, Canada, where six strata of rock salt have been found.

THE DEEPER SALT WELLS OF SAGINAW VALLEY.

Dr. S. S. Garrigues, for the purpose of giving the manufacturers some idea of the prospect of finding another supply of salt brine by sinking wells to a lower level than has yet been done, gives the depth and capacity of some wells that have been put down at other localities, all of which have without doubt reached another basin, and which he thinks may be reached on the Saginaw river:

PORT AUSTIN, HURON COUNTY.

The first well that we have good record from is the Port Austin. This well stands in the upper part of the Waverly group, being the sandstones of the Point of Barques. The first 275 feet of the well being in a mixture of sandy shales; succeeding this we have a series of blue and red shales continuing to near 1,100 feet. At this point a very white and porous sand rock was struck, there being about 100 feet. This sand rock contained an abundant supply of brine, and has since been improved by cleaning and scraping the well. The capacity of the well is over 20 gallons to the minute, filling a cistern 30x30 in 16 to 17 hours. The brine shows 92 degrees by salometer. The offset is down 600 feet, and the pumping chamber just below. The well has an overflow of fresh water.

CASEVILLE, HURON COUNTY.

The first salt well put down in this locality was for Frank Crawford. This well starts at the top of the carboniferous limestones which outcrop near Wild Fowl Bay. From here it passes through the same formations as found on the Saginaw river, until a sand rock containing strong brine is struck at 850 feet. There was near 100 feet of this formation, being mixed with sandy shales. The well was pumped at this depth for some time, nearly a year, but not being satisfied with the supply of brine, Mr. Crawford determined to put down another well, and this time he proposed to go deeper and see what he could find. Accordingly another well was started. After passing through the above mentioned formation a continued series of blue shales, followed by red and brown shales, was found, which continued until a sand rock was struck at the depth of 1,650 feet. Of this there was from 100 to 120 feet, making the entire depth of the well from 1,760 to 1,770 feet. And now at this place I would like to

correct an impression or report that has gone out—the rock salt was found in this sandstone formation. It was so given out at the time the well was bored, but subsequent borings and closer operations have disproved this statement. In this sand rock a strong brine was found, and an attempt made to pump from it alone, but the supply not being much greater the tube was raised and the brine from the two sand rocks was pumped together, giving a supply for about 125 barrels of salt each day, it being calculated that the lower rock gave a supply equal to about 75 barrels. All the other wells of this locality have been put down to this lower sand rock, but no rock salt has been found.

At Bay Port, ten miles from Caseville, a well has been put down to the same depth as the Caseville well, but as it has not been put in operation I cannot report the capacity of the well. This finishes the history of the salt wells on the south side of the Saginaw Bay that have any bearing on the prospect of finding salt brine in the lower sand rock of the Waverly group. Let us now cross over the Saginaw Bay and examine the record of salt wells there.

EAST TAWAS, IOSCO COUNTY.

The first well put down at this locality was for Grant & Son. This well starts in the same geneological horizon as the Port Austin well, being just at the bottom of the gypsum formation with outcrops at Alabaster, and in the sandstone formation of the upper part of the Waverly group, and which, at East Tawas, is composed of sand plains. After passing through the sand formation, the borings show a succession of blue and red shales mixed with sand until the sand rock is struck at a depth of 800 feet. Over 100 feet of this sand rock was found, yielding an abundant supply of brine of 85 degrees by the salinometer. The capacity of the well seemed unlimited.

A second well was put at East Tawas by the East Tawas Mill company. This well, being only a short distance from the other well, passes through the same formations. It had about 100 feet of sand rock, passing from this formation to the black shales of Ohio, which as before mentioned underlaid the Waverly group and outcrop at Thunder Bay. This well also gives a very abundant supply of brine; actual running capacity of the well near 200 barrels of salt a day. Salinometer stands at 85 degrees. Analysis shows great similarity to the Port Austin and Caseville brine.

AU SABLE.

We now pass out of the Tawas Bay to Au Sable, where two wells have been put down during the last year.

The first well was put down by Smith, Kelley & Dwight. This well commences in the sand formation similar to East Tawas, from which it is distant about 13 miles. After leaving this there is blue shale mixed with sand, followed by the red shales and some black shale until the sandstone rock was struck at 960 feet, of which there was 80 feet. The supply of brine in this well is sufficient to make 70 barrels of salt per day.

Brine shows salinometer strength of 92 degrees.

Loud, Gay & Co. have also put down one well and are now putting down another. The borings were as above described, but they were not so fortunate as their neighbors, and had only 60 feet of continuous sand rock, when passing into shales followed by 10 or 12 feet more sand rock. The entire depth of the well is 1,160 feet. The supply of brine is even less than the other well, being about 65 barrels of salt a day.

Since the record of these wells was given, four wells have been bored at Mid-

land, Midland county, within a few miles of the original well described in the beginning of this report. These borings struck, at a depth of 1,200 feet, the same sand rock, containing brine, which in Saginaw Valley was found at a depth of 900 feet. The boring penetrated the sand rock about 100 feet, making the well in all 1,300 feet in depth. The strength of brine, as shown by the salinometer, was 115 degrees, but loaded with some impurities which made the manufacture of a good commercial article one of great care.

More recently a boring has been made at Manistee with results which indicate the touching the same salt rock which has been found at Goderich, Canada. The well, however, is still incomplete, and it is too early to speak more definitely.

WELL-BORING MACHINERY.

The proper location having been selected for the salt well, a drill house, 16 by 30 feet, with a tower, is erected. This is large enough for a boiler, small portable engine, and a forge for repairing tools and keeping the drill sharp.

The tower or derrick has a height of 50 feet, or is high enough to draw out the drilling poles. The tool with which the boring or drilling is done is a drill, three feet long, shaped at one end like a chisel, and made of the best quality of steel.

The drill is screwed into the sinker, which is a round iron bar 40 feet long and three inches in diameter, and weighing about 2,000 pounds.

Attached to the sinkers by strong screws are the "jars;" these are about seven feet long and made of good iron. The "jars" are two slotted links, moving up and down within each other, and are intended to increase the force of the blow of the drill upon the rock by allowing it to fall with a sudden jerk.

The jars are attached by a screw to the drill pole, which is, in turn, connected by a swivel to a chain. The chain is fastened to an ordinary "walking-beam" of wood, driven by an engine of small horse-power.

The beam rises and falls continually over the mouth of the well, the chain which suspends the tool passing over the end of the beam being so arranged that it can be let out as the hole deepens, at the same time lifting the tool or drill and allowing it to drop with measured stroke on the rock, which is thus gradually drilled out. A workman sits at the mouth of the well, having the pole grasped by his hands, and after every stroke the poles are slightly turned so as to turn the drill which is working on the bottom, thus keeping the well true and circular in shape.

While the well is in process of boring, the tools are frequently removed and the sand pump introduced to remove the loose matter from the bottom of the well, which is done by means of a suction valve. The sand pump removes all the ground rock sand, and takes up at times stones an inch or more in size. In commencing the well, a strong wooden box eight inches square, made from 2-inch plank, is driven down into the ground, say from 14 to 16 feet. Inside of this an 8-inch iron tube or casing is put down as fast as the alluvial or drift material overlying the rock formation is broken up by the drill and taken out by the sand pump; this continues until the solid rock is reached.

At this point considerable care should be taken that the opening into the rock is perfectly round and well finished by the drill; for the casing should be set so firmly in the rock as to prevent any sand or gravel from running in under the tube, and thus getting in on top of the drill and endangering its becoming fastened in the well.

The rock-drilling now commences and continues to the depth to which it is

proposed to sink the well. After the drilling is done, the sides of the well are smoothed off with a tool called a reamer.

In most of the salt wells on the Saginaw river an offset is placed in the well at a short distance above the lower sand rock. Below the offset the size of the well is lessened half an inch in diameter.

On this offset is made the so-called rock-packing, the hole being drilled bevelling so as to receive a tightly-fitting iron collar or funnel-shaped piece of metal. A tube corresponding to the size of the upper part of the well is made to rest on this rock-packing as the offset, and runs to the top of the well; in this way all the weak brine from the upper rock and any fresh water that may come into the well above the offset are shut off. Below the offset the tube continues in reduced size to the locality of the lower sand rock, at which point the pumping chamber containing the pumping valves is placed.

In the early history of salt well boring in Michigan, the pressure of the brine in the well tube forced it within 100 feet of the surface. More recently, owing no doubt to the great demand for brine, it does not rise so high. It only requires a small amount of power, after the pumping rods are properly balanced, to lift the brine out of the well into the settling tanks.

PUMPING BRINE.

Often in starting up a new salt well the brine is weak, that is, shows a small percentage of salt by the salinometer. This arises from the fact that a large quantity of fresh water or weak brine from the upper formations has passed down into the well during the time the well was opened or being tubed. To test this point, and to bring the brine up to the usual strength of salt brines, the pump is put in operation and run for some time. If the brine continues to show an increase of strength on being tested by the salinometer, the pumping is continued until the strength of brine remains permanent at such a percentage as wells of equal depth in the same locality have shown.

If, however, the brine does not increase in strength, there are strong probabilities that there is a leakage of fresh water or weak brine into the well at the offset. This should be remedied at once—the more so if the well is a deep one, such as most of those in the Saginaw Valley are; for in this case the offset in the well is below the so-called gypsum formation, and you are drawing in and mixing with your strong brine a weak brine from these formations which has a higher percentage of gypsum.

This mixing of the two brines in the well and tubing causes a precipitation or separation of the gypsum upon the pumping rods and in the pumping chamber. If this is not stopped, it will eventually close up the valves and prevent them from being drawn out of the chamber. More than one instance has been known where parties have suffered much extra expense in not attending to this kind of leakage.

A manufacturer, in starting up his well pump, may also find that he has a short supply of brine, and the brine in the well tube runs down as soon as the pump is stopped. In this case he may have strong suspicions that his well tube is defective, or that the joints are not put together tightly, causing a leakage. To ascertain where this is, the tubing should be lifted out, the lower valve being allowed to remain in. As the tubing is being drawn, the pressure of the column of brine in the tube on the joints or imperfections will show where the leakage is. If the tubing is imperfect it should be taken out and replaced by perfect tubing. When the leakage is at the joint, a new thread should be cut upon it, or the joint should be screwed together more tightly.

It is very important that the salt manufacturer should ever be on the look-out for these leakages, as they may and do often arise from a jarring of the tubing by running the pump faster than the supply of brine comes to the pumping chamber, causing a vacuum and producing the so-called pounding of a well. The capacity of a well has been very materially affected by such a leakage, increasing the expense of pumping from 50 to 100 per cent.

The supply capacity of a well is also very materially increased by the position of the pumping chamber in the well. In the early history of salt wells in Michigan, the pumping chamber was generally placed a short distance below the offset. More recent tests go to prove that the best location for the pumping chamber is at or very near the point where the largest supply of brine comes into the well, and that point is the lower portion of the sand rock, or within a short distance of the bottom of the well.

In pumping a well it is also important that the weight of the pumping rods should be evenly counterbalanced by a weight on the other end of the walking-beam; this relieves the engine, the only weight to be lifted being the brine.

The stroke of the piston in the pumping chamber should be made as long as possible, and the motion of the engine should not be over 32 revolutions to the minute. In this way about the entire supply of brine in the well is obtained without forming a vacuum, thus preventing the pounding of the well and the danger of parting the pumping rods or jarring the tubing loose at the joints, causing leakage.

The capacity of salt wells varies in different localities from 12 to 20 gallons per minute—the size of the well and porosity of the sand rock having much to do in increasing the amount. A good well will fill a cistern 20x30x6 feet in about 20 hours. A salt well in Saginaw City, owned by Pierson, Wright & Co., produced enough brine during a manufacturing season of eight months to make over 26,000 barrels of salt. At East Tawas the wells, 3½ inches in diameter, fill a cistern of the above size in about 12 hours. At Port Austin the well fills a cistern in 17 hours.

TESTING THE STRENGTH OF BRINES BY SALINOMETER, WITH COMPARATIVE TABLES.

The following table is extracted from Alexander Winchell's report on the Geology of Michigan, published in 1861; it has been thought advisable to reprint it at length as a guide to our salt manufacturers.

"Pure water dissolves, at ordinary temperature, a little over one-third its weight of salt, or from thirty-five to thirty-six hundredths. The amount varies somewhat with the temperature, and the results of different experiments are, moreover, not perfectly accordant; but from the most accurate observations, it appears that 100 parts by weight of pure saturated brine, at temperatures from 32° to 70° Fahr., contain from 26.3 to 26.7 parts of salt. Some earlier determinations, however, gave but 25.7 parts, and upon this figure the table was calculated.

"The specific gravity of a saturated brine at 60° Fahr. is 1.205 pure water, being 1.000. The salinometer employed in many salt works for fixing the value of brine is an areometer with an arbitrary scale divided into 100 parts. The density of water on this scale is represented by 0° and that of saturated brine by 100°. Each degree of the salinometer, therefore, corresponds very nearly to one-quarter of one per cent of salt. In the following table the true specific gravity, with the corresponding degree of the salinometer and of the hydrometer of Baumé, is given in the first three columns. The succeeding

columns give the percentage of salt in a pure brine for each degree of the salinometer, the number of grains of salt to the wine pint of 36,625 cubic inches, and the number of gallons of such brine required to yield a bushel of salt weighing 56 pounds.

"From this table the properties and capabilities of any brine may be ascertained by knowing its strength as shown by the salinometer. Suppose, for instance, the salinometer shows 53°. The table shows at a glance that this corresponds to 13.78° of Baumé's hydrometer, a specific gravity of 1.100, and a percentage of 13.62; while a wine pint of the brine would furnish 1,092 grains of a solid residue, and 44.7 gallons would produce a bushel.

"If the strength of a brine is expressed by giving its specific gravity, and we wish to compare the strength as thus stated with that of another brine given in degrees of the salinometer, or the number of grains in a pint, and we look in the column of 'specific gravity' in the foregoing table and find the number which agrees nearest with the given one, then on the same horizontal we have all the synonymous expressions for the same strength and it is seen at once whether the brine with which we wish to make the comparison is stronger or weaker.

"Or suppose, thirdly, that a land-owner desires to know the comparative strength of a brine spring on his premises, while he possesses no instrument for taking specific gravity. Let him evaporate a wine pint and weigh the residue, or take it to the apothecary to weigh; then the number of grains found in the fifth column of the table will show him all the equivalent expressions:

TABLE—*Giving a Comparison of Different Expressions for the Strength of Brine, from Zero to Saturation.*

Degrees Salinometer.	Degrees Baume.	Specific Gravity.	Per Cent of Salt.	Grains of Salt in one Pint.	Gallons for a Bushel of Salt.
0	0	1.000	0	0	Infinite.
1	.26	1.002	0.26	19	2599
2	.52	1.003	0.51	38	1297
3	.78	1.005	0.77	56	863
4	1.04	1.007	1.03	75	647
5	1.30	1.009	1.28	94	516
6	1.56	1.010	1.54	114	430
7	1.82	1.012	1.80	133	368
8	2.08	1.014	2.06	152	321
9	2.34	1.016	2.31	171	285
10	2.60	1.017	2.57	191	256
11	2.86	1.019	2.83	210	232
12	3.12	1.021	3.08	229	213
13	3.38	1.023	3.34	249	196
14	3.64	1.025	3.60	269	182
15	3.90	1.026	3.85	288	169
16	4.16	1.028	4.11	308	158
17	4.42	1.030	4.37	328	149
18	4.68	1.032	4.63	348	140
19	4.94	1.034	4.88	368	133
20	5.20	1.035	5.14	388	126
21	5.46	1.037	5.40	408	120
22	5.72	1.039	5.65	428	114
23	5.98	1.041	5.91	448	109
24	6.24	1.043	6.17	469	104
25	6.50	1.045	6.42	489	99.7
26	6.76	1.046	6.68	510	95.7
27	7.02	1.048	6.94	530	92.0

TABLE—*Continued.*

Degrees Salinometer.	Degrees Baume.	Specific Gravity.	Per Cent of Salt.	Grains of Salt in one Pint.	Gallons for a Bushel of Salt.
28	7.28	1.050	7.20	551	89.5
29	7.54	1.052	7.45	572	85.3
30	7.80	1.054	7.71	592	82.3
31	8.06	1.056	7.97	613	79.5
32	8.32	1.058	8.22	634	76.9
33	8.58	1.059	8.48	655	74.5
34	8.84	1.061	8.74	676	72.1
35	9.10	1.063	8.99	697	69.9
36	9.36	1.065	9.25	719	67.9
37	9.62	1.067	9.51	740	65.9
38	9.88	1.069	9.77	761	64.1
39	10.14	1.071	10.02	783	62.3
40	10.40	1.073	10.28	804	60.6
41	10.66	1.075	10.54	826	59.1
42	10.92	1.077	10.79	848	57.6
43	11.18	1.079	11.05	869	56.1
44	11.44	1.081	11.31	891	54.7
45	11.70	1.083	11.56	913	53.4
46	11.96	1.085	11.82	935	52.2
47	12 22	1.087	11.08	957	50.9
48	12.48	1.089	12.34	979	49.8
49	12.74	1.091	12.59	1002	48.7
50	13.00	1.093	12.85	1024	47.6
51	13.26	1.095	13.11	1047	46.6
52	13.52	1.097	13.36	1070	45.6
53	13.78	1.100	13.62	1092	44.7
54	14.04	1.102	13.88	1115	43.8
55	14.30	1.104	14.13	1137	42.9
56	14.56	1.106	14.39	1160	42.0
57	14.82	1.108	14.65	1183	41.2
58	15.08	1.110	14.91	1206	40.4
59	15.34	1.112	15.16	1229	39.7
60	15.60	1.114	15.43	1252	38.9
61	15.86	1.116	15.68	1276	38.2
62	16.12	1.118	15.93	1299	37.5
63	16.38	1.121	16.19	1322	36.9
64	16.64	1.123	16.45	1346	36.2
65	16.90	1.125	16.70	1370	35.6
66	17.16	1.127	16.96	1393	35.0
67	17.42	1.129	17.22	1417	34.4
68	17.68	1.131	17.48	1441	33.9
69	17.94	1.133	17.73	1465	33.3
70	18.20	1.136	17.99	1489	32.7
71	18.46	1.138	18.25	1513	32.2
72	18.72	1.140	18.50	1538	31.7
73	18.98	1.142	18.76	1562	31.2
74	19.24	1.144	19.02	1587	30.7
75	19.50	1.147	19.27	1611	30.3
76	19.76	1.149	19.53	1636	29.8
77	20.02	1.151	19.79	1661	29.4
78	20.28	1.154	20.05	1686	28.9
79	20.54	1.156	20.30	1710	28.5
80	20.80	1.158	20.56	1736	28.1
81	21.06	1.160	20.82	1761	27.7
82	21.32	1.163	21.07	1786	27.3
83	21.58	1.165	21.33	1811	26.9
84	21.84	1.167	21.59	1837	26.5
85	22.10	1.170	21.84	1862	26.2
86	22.36	1.172	22.10	1888	25.8
87	22.62	1.175	22.36	1914	25.5

TABLE—*Continued.*

Degrees Salinometer.	Degrees Baume.	Specific Gravity.	Per Cent of Salt.	Grains of Salt in one Pint.	Gallons for a Bushel of Salt.
88	22.88	1.177	22.62	1940	25.1
89	23.14	1.179	22.87	1966	24.8
90	23.40	1.182	23.13	1992	24.5
91	23.66	1.184	23.39	2018	24.2
92	23.92	1.186	23.64	2045	23.8
93	24.18	1.189	23.90	2072	23.5
94	24.44	1.191	24.16	2098	23.2
95	24.70	1.194	24.41	2124	23.0
96	24.96	1.196	24.67	2151	22.7
97	25.22	1.198	24.93	2178	22.4
98	25.48	1.201	25.19	2205	22.1
99	25.74	1.203	25.44	2232	21.8
100	26.00	1.205	25.70	2259	21.6

"In making use of the table it must be remembered that it will prove accurate only for *pure solutions of salt.* In this state the chloride of calcium and magnesium, which existed to some extent in our brines, will cause the table to make a showing too favorable. As the percentage of impurities is a variable quantity, it was impossible to make allowance for them in the table. Though we cannot, therefore, construct one practically accurate, it is not thought best to discard all attempts at a table. As long as it is thought desirable to use the salinometer it seems to be a matter of convenience to have at hand the ready means for converting its reading into the equivalent expressions.

"It must also be borne in mind that brines of the same strength possess different densities, depending upon the temperature, the density rapidly diminishing as the temperature rises. It is consequently necessary to experiment on brines at a uniform or standard temperature. The ordinary standard for hydrometrical operation is 60° Fahrenheit's thermometer, but the standard temperature at the Onondaga salines is 52°, that being the natural temperature of the brine as it issues from the well.

BRINE ANALYSES.

The first practical attempt at salt well boring in Grand Rapids was commenced August 12th, 1859, and finished October 14th, being 257 feet deep. A sample of brine taken at this time was analyzed by Prof. Fish, with the following results:

Specific gravity	1.01752	
Fixed constituents	2.33385	per ct.
Carbonate of iron	0.00145	
" lime	0.00473	
" magnesia	0.00034	
Free carbonic acid	0.00603	
Silicic acid	0.00025	
Sulphate of lime	0.13120	
Chloride of calcium	0.27641	
Chloride of magnesium	0.07196	
Chloride of potassium	0.01561	
Chloride of sodium (salt)	1.73696	
Loss	0.08841	
	2.33385	

An analysis of brine from the first East Saginaw well, made by Prof. Douglass April 11th, 1860, is as follows:

Specific gravity	1.179
Saline matter, per cent	22.017
Chloride of sodium (salt)	17.912
" calcium	2.142
" magnesium	1.522
Sulphate of lime	.116
Carbonate of iron	.105
Chloride of potassium	.220
Water	77.983
	100.000

Composition of brines taken from various salt wells on Saginaw river, in October, 1862, and analyzed by Dr. C. A. Goesmann—this investigation being directed to ascertain their commercial value.

Portsmouth, Bay county, Michigan. Depth of well, 664 feet. Brine, 54° by salinometer.

Sulphate of lime (gypsum)	0.4884
Chloride of calcium	0.3472
" magnesium	0.4333
" sodium (salt)	12.5315
Saline matter	13.8004
Water	86.1996
	100.0000

Gillmore well, Bay City, Michigan. Depth of well, 505 feet. Brine, 65° by salinometer.

Sulphate of lime (gypsum)	0.3961
Chloride of calcium	0.5302
" magnesium	0.4115
" sodium (salt)	15.2674
Saline matter	16.6052
Water	83.3948
	100.0000

The two brines, as the depth of the wells will show, are from the upper salt-bearing sand rock, and are quite characteristic of this formation as shown by the large percentage of gypsum and low percentage of chlorides.

Swift & Lockwood's well, Saginaw City. Depth of well, 860 feet. Brine, 86° salinometer.

Sulphate of lime (gypsum)	0.0983
Chloride of calcium	2.6430
" magnesium	1.0685
" sodium (salt)	17.5103
Saline matter	21.3201
Water	78.6799
	100.0000

East Saginaw Salt Manufacturing Company, East Saginaw. Depth of well, 806 feet. Salinometer, 80°.

Sulphate of lime (gypsum)	0.1516
Chloride of calcium	2.2665
" magnesium	0.9629
" sodium (salt)	16.8636
Saline matter	20.2446
Water	79.7554
	100.0000

Bangor Salt Manufacturing Company, Banks, Bay county, Michigan. Depth of well, 774 feet. Brine, 95° salinometer.

Sulphate of lime (gypsum)	0.0722
Chloride of calcium	2.9611
" magnesium	1.2612
" sodium (salt)	19.8595
Saline matter	24.1540
Water	75.8460
	100.0000

These three specimens of brine, as the depth of the wells will show, are from the lower salt-bearing sand rock, called the Napoleon sandstone by Winchell. The analysis shows a decrease in the percentage of gypsum, an increased percentage of the earth chlorides and increased quantity of salt.

These are the representative brines of the Saginaw river, and are those which are mostly worked for their salt.

Composition of brines taken from wells outside of the Saginaw valley:

Ayres & Co.'s salt well, Port Austin, Huron county, Michigan. Depth of well, 1,198 feet. Brine, 88° salinometer.

Sulphate of lime	0.0129
Chloride of calcium	3.1274
" magnesium	1.5675
" sodium (salt)	17.6161
Saline matter	22.3239
Water	77.6761
	100.0000

Emery Bros'. salt well, East Tawas, Iosco county, Michigan. Depth of well, 905 feet. Salinometer 85°.

Sulphate of lime (gypsum)	0.0350
Chloride of calcium	3.4843
" magnesium	1.2433
" sodium (salt)	15.6141
Saline matter	20.3767
Water	79.6233
	100.0000

The analyses of these brines show a marked increase in the earthy chlorides, and are without doubt from a lower saliferous horizon, located in the Devonian strata, and consequently intermediate between the Onondaga formation and the Michigan salt group—this same formation having been struck at Caseville, Huron county, at the depth of 1,750 feet, and at Blackmar's Mills, 13 miles east of East Saginaw, at the depth of 1,675 feet. The new wells going down at Oscoda, Michigan, are without doubt in this formation also.

Composition of brines taken from wells on the Lake shore of Huron county, and representing an excellent quality of brine for salt manufacturing—nearly approaching the Goderich brines in freedom from the earthy chlorides:

Sand Beach well, Huron county. Depth of well, 702 feet. Brine, 84° salinometer. Analysis by Dr. S. P. Duffield.

Sulphate of lime (gypsum)	0.2539
Chloride of calcium	0.3000
" magnesium	0.1591
" sodium (salt)	22.5673
Saline matter	23.2803
Water	76.7197
	100.0000

White Rock well, Huron county. Depth of well, 566 feet. Brine, 78.5° salinometer.

Sulphate of lime (gypsum)	0.2623
Chloride of calcium	0.5373
" magnesium	0.4106
" sodium (salt)	18.9134
Saline matter	20.1236
Water	79.8764
	100.0000

The following analyses of Michigan brines, made by H. C. Hahn, Ph.D., will show the chemical composition of other brines not included in the above list:

Oneida Salt Company, Crow Island, Zilwaukie. Specific gravity of brine, 1.1864.

Sodic chloride (salt)	19.304
Calcic chloride	2.623
Magnesic chloride	1.343
Calcic sulphate (gypsum)	0.080
" carbonate	trace
Magnesic carbonate	"
Ferrous carbonate	0.0054
" chloride	0.0032
Magnesic bromide	traces
Carbonic acid	"
Water	76.269
	99.6276

New York Solar Salt Company, Zilwaukie. Specific gravity of brine, 1.1930.

Sodic chloride (salt)	19.914
Calcic chloride	3.040
Magnesic chloride	1.419
Calcic sulphate	0.073
" carbonate	0.0010
Magnesic carbonate	0.0006
Ferrous carbonate	0.0058
" chloride	0.0038
Water	75.041
	99.498

Michigan Solar Salt Company, Zilwaukie. Specific gravity of brine, 1.1900.

Sodic chloride	19.671
Calcic chloride	2.916
Magnesic chloride	1.381
Calcic sulphate	0.082
" carbonate	0.0010
Ferrous carbonate	0.0123
Magnesic carbonate	0.0015
Carbonic acid	trace
Water	75.715
	99.7800

Smith, Kelly & Dwight well, at Oscoda, Iosco county, Michigan. Specific gravity, 1.182. Depth of well, 1,070 feet.

Sodic chloride (salt)	17.93
Calcic chloride	4.21
Magnesic chloride	1.93
Calcic suphate	trace
" carbonate	"
Saline matter	24.19
Water	75.81
	100.000

Analysis of a Saginaw City brine, made by E. M. Vanflint, C. E., of Union College. Depth of well, 741 feet. Salinometer 90° at 56° Fahrenheit:

Sodic chloride	17.940
Calcic sulphate	0.119
" chloride	2.591
Magnesic chloride	0.627
Ferrous carbonate	0.092
Aluminous "	0.022
Bromide of magnesium	0.236
Iodine, potassium, and lithum	trace
Water	78.373
	100.000

RECEPTION AND SETTLING OF BRINE.

The salt manufacturer having satisfied himself in regard to the quantity and quality of the brine supply must now be prepared with cisterns to store his brine during the process of settling.

These cisterns or outside settlers were formerly built in size 20 by 30 feet and 6 feet deep, having a capacity of 25,000 gallons. More recently the size of these has been increased to suit the wants of the manufacturer. They are built of sound two or three-inch plank, well and properly keyed together by strong gripes, and are also calked to prevent leakage. These cisterns are elevated on piling or framed timbers, high enough to allow the settled brine to flow through pipes to the blocks.

The connections from the cisterns into the pipes are six inches above the bottom, the flow of the brine being controlled by gates. The supply pipes from the cisterns are usually made of wooden pump logs having a three-inch bore.

The brine, as shown by the analyses, contains a small percentage of carbonate of protoxide of iron, held in solution by an excess of carbonic acid.

If the brine was boiled down or evaporated with this iron in, it would give the salt a red color and very materially affect its commercial value.

As soon as the cistern is filled with brine, preparation should be made to settle it. A tight box large enough to hold a barrel or more of water is placed on the top of the cistern. In this a proper quantity of fresh burnt lime is slacked with fresh water, enough being afterward added to fill the box so as to make a whitewash or milk of the lime. This mixture being a caustic lime is freely sprinkled over the brine. The brine is then thoroughly "plunged"—that is, it is stirred up until the lime is well mixed with the brine. The caustic mixture of lime having a strong affinity for the carbonic acid extracts the same from the brine, thus releasing the iron which is precipitated with the lime to the bottom of the cistern as an insoluble peroxide of iron. The brine is then allowed to rest for 48 hours, when it is quite clear and ready for the boiling house or block. This process is called "settling," and on the care with which it is conducted depends much of the success in making good salt.

EVAPORATION OF BRINE.

Having made a stock of settled brine, the next process in the manufacture of salt is the evaporation of the brine; and this is effected by three different methods:

First, By the direct application of fire-heat to kettles and pans;

Second, By the use of steam—either exhaust steam from saw-mills or steam generated by flue boilers built expressly for the purpose;

Third, By solar evaporation.

EVAPORATION OF BRINE IN KETTLE BLOCKS.

A kettle block for evaporation of brine consists of a wooden building, 140 feet long by 45 to 50 feet wide, with an elevation of 18 feet, so arranged as to admit of the steam passing out of the ventilators. In this building are set from 50 to 60 kettles, having each a capacity of 100 to 120 gallons. The kettles are set in two rows over arches running from the mouth or furnace to the chimney. These are called "arches." These arches run close together, with a dividing wall between them; the kettles are set close together in a row, resting on the dividing wall on the one side and on the outside wall on the other.

The fire arch or furnace at the front is three feet from the bottom of the kettles; from here the bottom of the arch gradually rises so that under the back kettles the space is only 10 to 12 inches. Here the flue passes into the chimney, which is about 40 to 50 feet high.

Between the arches and the salt bins, which are under the same building, is the sidewalk. On this sidewalk the salt boiler operates in drawing the salt from the kettles into the draining baskets, which, when it is sufficiently drained, are wheeled off to the salt bins on this sidewalk or platform. The bins, which run the entire length of the block, are divided off in sections, and are made with open floors for the proper drainage of the salt.

Through the center of the block, just on top of the middle wall, two sets of pump logs or pipes are laid—one for fresh water and one for the settled brine, each of them being supplied with faucets for each kettle.

The kettles, after being well cleansed, are filled with brine, and boiling soon commences after the fire is under good headway. A scum rises to the surface, which is taken off with a skimmer.

Of late years, owing to the dry and light material used for fuel (being the refuse slabs from saw mills), the first 10 or 15 kettles in the arch are protected from the excessive heat by patent arches which are built over the fire flue and directly under the bottom of the kettle. By this arrangement, and a narrowing of the flue, the heat is distributed more evenly through the entire arch and the kettles boil more regularly.

Soon after the brine commences to boil the crystals of salt commence to form on the top and then fall to the bottom. When the brine is boiled down to about one-third the salt is dipped out with a ladle and thrown into a basket, which is placed over one side of the kettle. The salt is allowed to remain in the basket for two or three hours, the bitter water containing the earthy chlorides being thus drained off. Thorough drainage is considered an important point in this mode of manufacture. The balance of the brine or bitter water remaining in the kettle is now bailed out and thrown into the drainage trough. The kettle is then rinsed out with fresh water and again filled up with brine.

The difference of the time in which the front and the back kettles boil down varies from four hours in the front to twelve hours in the back. The kettle blocks are generally run day and night by four men, two boilers and two firemen, taking tours of twelve hours each. The average product of a good kettle block is 75 barrels of salt per day of 24 hours.

This process is rapidly becoming superseded by the more economical one of pan and steam blocks.

EVAPORATION OF BRINE IN PAN BLOCKS.

Pan blocks are buildings of various dimensions, built to accommodate the size of the pan, settlers and salt bins.

The pans are made of quarter-inch boiler-plate iron. They vary from 90 to 120 feet in length, being divided into sections of 30 or 40 feet, are 12 to 15 feet wide and from 10 to 12 inches deep. With some the sides are straight, the salt being raked to the side, lifted out with a shovel, and thrown on the draining boards. In others the sides are flanged, and the salt is raked directly on to the draining boards.

Pans of the above size rest on three walls as in kettle blocks, the arches running directly under the pan to the chimney at the end. As the firing of these blocks is done mostly with slabs or light fuel, the first 30 or 40 feet are also

protected by patent arches thrown across the flues, thus dividing the heat more generally throughout the block.

The brine boils very rapidly in these blocks, and as the salt makes fast it requires much care and attention on the part of the workmen to keep the salt from baking on the bottom of the pan; this is prevented by raking out the salt almost as fast as it makes.

Improvements in heating pan blocks have been made of late years in those localities where the price of fuel is a consideration. A pan block of an improved plan for boiling the brine has been erected by Ayres & Co., of Port Austin, Huron county.

The block is 120 feet long, 43 feet wide, outside post 10 feet high and center post 18 feet high—almost too high to carry off the steam in winter. The length was also calculated for four pans. Three pans only were put on, being each 30 feet long and 16 feet wide on bottom, sides flanging and bolted to the draining boards.

The pans rest on seven walls, which are so arranged that they make two fire flues in the center and two return flues on the sides.

The center and outside walls run the entire length and width of the pan. All the walls are a foot wide at the top. The two fire flues which are under the middle of the pan on both sides of the center wall are 2½ feet wide. Height of grate to pan, 3½ feet. The return flues are next to the outside walls, under the sides of the pan, and are two feet wide. This gives a heating surface of 180 feet in length on both sides of the middle wall. The outside flues run into the chimney, which is placed at one side of the front of the block—the space under the pan being reduced to one foot.

The advantage of this arrangement of the flues is that as the brine boils freely over the fire flue the salt, as it makes, is thrown to the cool side of the pan, and therefore is not so liable to bake to the bottom of the pan before it is raked out. Another advantage is in the economy of the heating surface, the entire amount being well used up before it gets to the chimney. This is shown in the amount of salt made—Ayres & Co. reporting the making of 140 barrels of salt with 13 cords of hemlock wood in a day of 24 hours.

The brine for pan blocks is settled cold in the outside cisterns, and in most instances is brought to saturation by the inside steam settlers. The salt, as it makes in the pan, is drawn out by rakes upon the draining board, where it remains for a time, when it is shoveled into barrows and taken to the store bins for further drainage.

It is very desirable that the draining boards should be so arranged in pan blocks that the workmen should not be compelled to walk over them in the operation of drawing or wheeling off the salt.

EVAPORATION OF BRINE BY STEAM.

The evaporation of salt brine by the steam process is now producing the largest portion of salt made in Michigan. We take for the purpose of better describing the process a steam salt block which is 150 feet long, 122 feet wide, and has an elevation of 52 feet to the top of the ventilator. Height of ventilator, 16 feet. Included, therefore, in the above space are the inside settlers, grainers, salt bins, and packing room:

The inside steam settlers are 150 feet long, 11 feet wide, and 6 feet deep, made of four-inch plank, well keyed together and tightly calked. This block is supplied with seven grainers, 150 feet long, 11 feet wide, and 16 inches deep. Over

each grainer are the draining boards running the entire length. Passing through each settler and grainer, and near the bottom, are four-inch galvanized tubing, four to five in number, depending on the size of the grainer, through which exhaust or live steam is forced. In the steam as in the kettle process, the brine is first pumped into the outside settlers, where it is partially settled. It is then drawn into the inside steam settlers, where it is heated up by the steam pipes and brought to saturation—that is, a point just preceding the formation of salt crystals. It is allowed to remain until all sediment of iron has fallen to the bottom, by which time it becomes clear as crystal. The brine is now ready to be drawn into the grainers, which are filled to about two-thirds their capacity, or nearly full. As the settled brine comes into the grainers quite warm and fully saturated it soon commences to make salt, which forms on the surface of the brine and then falls to the bottom of the grainers, when a new lot of crystals are formed to fall in the same way. The brine is also occasionally stirred so as to make the crystals fine. Thus the evaporation continues for twenty-four hours, the temperature being kept at from 170° to 175° of Fahrenheit. The brine being sufficiently evaporated by this time, the workmen commence the "lifting." This is done by first washing the salt in the brine that is left in the grainers and then taking it out with shovels and throwing it on the draining boards, where it remains a number of hours for drainage. A large "lift" or "draw" fills the boards with salt, and it is a beautiful sight to see the salt as it comes white and sparkling from the brine. The salt should remain on the draining boards to drain thoroughly twenty-four hours if possible before going to the bins. It lies in the bins two weeks to complete the drainage, when it is ready for inspection and barreling for shipment.

SOLAR EVAPORATION OF BRINE.

The first preparation for solar evaporation is to have a series of covers or wooden vats. The covers are rectangular in shape, being 16 by 18 and from 6 to 8 inches deep. They are raised on wooden supports two to three feet from the ground, and are arranged in sets or strings. Each cover has a movable roof, which can be run on or off to protect or expose the brine, according to the weather. At the end of the string of graining covers, somewhat higher and deeper, are the "strings" of settling covers into which the brine is led from the store reservoirs or cisterns. No lime is used in settling the brine in this process; for in these deep rooms the brine absorbs a portion of oxygen from the air, by which means the carbonate of iron which is dissolved in the recent brine is converted into an insoluble peroxide of iron. In Syracuse a second series of covers is used to get rid of the gypsum which separates or is deposited in the form of a crystal. As the quantity of gypsum is very small in the Saginaw brines these rooms are now dispensed with.

As soon as there is a show of salt crystals, the first stage of the process is accomplished, and the saturated brine known as salt pickle is ready for the last stage. It is then drawn into the salt room or draining vats, in which the salt soon commences to crystallize on the bottom of the covers.

"One of the conditions required for a good, large-grained solar salt, which is most esteemed in the market, is that the bottom of the covers in the salt room should be as smooth as possible, rough surfaces favoring the deposition of numerous small crystals. It is also necessary to have the salt covers supplied with a sufficient supply of good pickle, so that the salt already deposited may always be covered. An exposure of the salt uncovered to the air favors the

formation of new small crystals, and the addition of an unfinished or not sufficiently concentrated pickle produces the same effect. It is also important that the waste or exhausted pickle from which the greater part of the salt has crystallized should be discharged from time to time, as its presence not only impairs the quality but diminishes the quantity of the salt deposited."

The time required for the evaporation of sufficient pickle to make a crop depends largely upon the weather, dry and clear weather being, of course, most favorable; six weeks or two months is the usual time. Three crops of salt a season are gathered—the first about the middle of July, the second in the early part of September, and the third at the end of October. The second crop is generally the best, as it is coarser than the others.

The crop of solar salt is gathered by first loosening it from the bottom of the "covers" with a rake or spud. It is then washed in the pickle that is still left in the covers and "gathered" to the street gunwale. Here it is shoveled into draining tubs, to remain a short time before being emptied into the salt carts for removal to the salt bins for further drainage.

TREATMENT OF CRUDE PRODUCT.

The legal time, fourteen days, required for drainage, having passed, the bins are opened and the salt is packed in barrels holding five bushels, or 820 pounds—each barrel being branded with the name of the firm or person manufacturing the same.

GRADES AND QUALITY OF MICHIGAN SALT.

The grades of salt established by the State Inspector are as follows:

NO. 1 SALT.

Fine—In barrels of 280 lbs., for general and for all family purposes.

Packers—In barrels of 280 lbs., suitable for packing and bulking meat and fish, one of the finest and best brands of salt for such purposes in the market.

Solar—In barrels of 280 lbs., when screened, branded C Solar C for coarse, and F Solar F for fine grades. The solar salt is equal in all respects to New York solar salt.

NO. 2 SALT.

Second Quality—All salt intended for No. 1 of any of the above grades, when for any other cause it is condemned by the inspector, is branded second quality and sold as such. This salt is good for salting stock, hay, hides, etc.

DAIRY SALT.

The State Salt Inspector, in his last annual report, has the following in reference to the manufacture of dairy salt:

There has been a great want of a good quality of this kind of salt so as to complete the list of Michigan salts now in the market. Several attempts have been made to start its manufacture, but none have been successful owing in a great part to the want of care in making an article of sufficient purity.

We have now the pleasure of stating that during the past summer the Michigan Dairy Salt Company, located at East Saginaw, was organized for washing, purifying, and grinding the salt, with a capacity of 200 barrels daily, and is now in successful operation, turning out a superior quality of dairy salt, as the fol-

lowing analysis will show. We can hardly realize the importance of the manufacture of this grade of salt, putting, as it does, the farmer in possession of, at a cheap rate, a quality of salt for dairy purposes that cannot be excelled:

ANALYSIS.

Sulphate of lime	0.57
Chloride of calcium	0.08
" magnesia	0.19
" sodium	99.03
Moisture	.23

AGRICULTURAL SALT.

The use of salt for fertilizing purposes is no longer an experiment but has been fully proven, not only scientifically and theoretically, but practically, by scores of our most successful agriculturists throughout the country. The Michigan manufacturers are now manufacturing a salt for fertilizing purposes that is peculiarly adapted to the use for which it is designed. It is entirely free from dirt or hard lumps and is made by a process which leaves incorporated in the salt all the valuable plant food as well as ingredients calculated to free and render soluble the ammonia already contained in the soil. There has been a good demand for this salt, chiefly second quality and refuse, during the past season, and the association has shipped large quantities, with excellent results so far as learned. Agricultural salt sells in this market at $3.50 per ton

The demand for agricultural salt is assuming extraordinary proportions. A sale of 1,200 tons of this commodity was made recently to a Minnesota party, and orders are daily received for car lots. Saturday the association received orders for fourteen cars of agricultural salt, nine for Minnesota, one for Dakota, two for Wisconsin, and two for Michigan. The value of salt as a fertilizer is becoming widely recognized, and the increasing demand will furnish a field for the disposition of the surplus production of the Michigan manufacturers beyond their most sanguine expectations.

Analyses of this salt have been made to determine its value as manure. It is so rusty that no one would dream of using it on his table, and if it were used to salt beef or fish the results would be disastrous, yet its value for manure may be seen from the results of analyses:

Common salt	87.74
Chloride of potassium	2.49
Sulphate of lime	1.68
Carbonates of lime and magnesia	.75
Oxide of iron	.87
Water	6.38
	99.91

Salt that contains 2½ per cent of chloride of potassium in place of the same amount of chloride of sodium is worth $1 a ton more for manure than pure salt.

DIRECTIONS as to the quantities of Salt and the time to be applied to different Grain, Roots, and other Crops.

	Cwt. Per Acre.			Best time for application.	May also be applied with advantage.	Remarks.
	Light sandy soil.	Middling loamy soil.	Heavy rich loam or drained clay.			
Wheat	4½-5	4 -4½	3 -4	Month before or month after seed time.	Top dressing in spring, either alone or mixed with guano or nit. of soda.	These quantities are calculated for soils in which there is an insufficiency of the elements of salt; but in such soils where an analysis would already show considerable quantities of soda and chlorides or muriates in various forms, smaller quantities than the annexed should be used, as also in the cases where salt has already been used in compost and with stable dung or where cattle are regularly fed salt.
Rye	5 -6	4½-5	3 -4			
Barley	6 -7½	6 -6	4 -5		Top dressing in May or beginning of June in dry seasons.	
Oats	6½-7½	6 -6½	4½-5			
Beans and peas	6 -6½	4½-5	3½-4			
Rape seed	6 -7½	5 -6	4 -5			
Flax	4 -5	3½-4	2½-3			
Hops	6 -6½	5 -6	4- 5		Top dressing in dry seasons, after the plants are fairly up; alone or with guano.	
Potatoes	6 -7	4 -5	3 -3½			
Turnips, mangolds, beets and carrots	5 -6	4 -5	3½-4			
Gardens	7½-10	7 -8	6 -6½	September to December.	Sprinkling with a strong solution when there is mildew.	
*Fruit trees						
Fallows	9 -10	8 -9	7½-8	Breaking up.		
Clover and grasses (artificial)	6½-7½	6 -6½	4 -5	Month before seed time.	Top dressing in dry seasons in May or June.	
Meadows and grasses (natural)	6½-7½	5 -6	4 -5	Not later than November.		

HAY.—10 pounds to 20 pounds per ton or ⅛ to ¼ of a cwt. per load at stacking.
COMPOSTS.—One cwt. per load, gradually, as the compost is prepared.
HORSES, CATTLE, SHEEP, &C.—Pieces of rock salt in an accessible part of the field or stables.
Salt should never be applied with the seed, or on very cold, wet, undrained land.

*In trenches on each side of the tree, four pounds.

ANALYSIS OF SALT.

Experience proves that the best quality of salt can be made from Michigan brines, and that a great preponderance of the salt sold in the market has been found as pure and as efficient an antiseptic as any mined or manufactured elsewhere, either in our own or foreign countries.

The following are the analyses of the various grades of Michigan salt:

Kettle salt made by the East Saginaw Salt Company, East Saginaw, Michigan. Analysis by Dr. C. A. Goesmann:

Sulphate of lime	0.3165
" calcium	0.3564
Chloride of magnesium	0.1408
Moisture	3.3441
Chloride of sodium (salt)	95.8422
	100.0000

Carrollton Salt Company, Carrollton, Michigan. Kettle salt. Analysis by Dr. H. C. Hahn:

Sulphate of lime	0.405
Chloride of calcium	1.127
" magnesium	0.517
Moisture	3.292
Chloride of sodium (salt)	94.669
	100.0000

Pan salt made by Bay City Salt Company, Bay City, Michigan. Analysis by S. S. Garrigues, Ph. D.:

Sulphate of lime	0.696
Chloride of calcium	0.329
" magnesium	0.340
Moisture	1.346
Chloride of sodium (salt)	97.288
	100.000

Pan salt made by Taylor & Co., Zilwaukie. Analysis by Dr. H. C. Hahn:

Sulphate of lime	0.088
Chloride of calcium	0.737
" magnesium	0.445
" sodium (salt)	98.730
	100.000

Steam salt made by Buffalo Salt Company, East Saginaw, Michigan. Analysis by Dr. H. C. Hahn:

Sulphate of lime	0.478
Chloride of calcium	1.365
" magnesium	0.694
Moisture	3.478
Chloride of sodium (salt)	94.366
	100.000

Steam salt made by New York and Michigan Salt Company, at Zilwaukie. Analysis by Dr. H. C. Hahn:

Sulphate of lime	0.363
Chloride of calcium	0.699
" magnesium	0.313
Moisture	3.308
Chloride of sodium (salt)	95.327
	100.000

SOLAR SALT.

Solar salt made by East Saginaw Salt Company, East Saginaw. Analysis by Dr. C. A. Goesmann:

Sulphate of lime	0.3165
Chloride of calcium	0.3564
" magnesium	0.1408
Moisture	3.3560
Chloride of sodium (salt)	95.8333
	100.0000

Solar salt made by New York and Michigan Salt Company, at Zilwaukie. Analysis by Dr. H. C. Hahn:

Sulphate of lime	0.173
Chloride of calcium	0.743
" magnesium	0.417
Moisture	2.197
Chloride of sodium (salt)	96.470
	100.000

Analysis of pan salt from White Rock, Michigan, made by Dr. C. A. Goesmann:

Sulphate of lime	0.81
Chloride of calcium	0.41
" magnesium	0.28
Water	1.80
Chloride of sodium	96.70
	100.00

Analysis of Michigan barrel salt, made by James R. Blaney, of Chicago:

	Packer.	Com. Fine.
Chloride of sodium (pure salt)	96.453	96.779
" calcium	.152	.449
" magnesium	.288	.480
Sulphate of lime (gypsum)	.427	.292
Moisture	2.680	2.000
	100.000	100.000

Average analysis of common salt, made by Dr. C. A. Goesmann, of Syracuse salt:

Sulphate of lime	1.2550
Chloride of calcium	0.1550
" magnesium	0.1369
Moisture	3.0000
Chloride of sodium (salt)	95.4531
	100.0000

FUEL.

The fuel used in kettle blocks is cord wood, mixed soft and hard, refuse slabs, and sawdust from saw-mills. Mixed wood now costs $1.25 per cord, delivered at block. Slabs cost 45 to 50 cents per cord at the mills.

A kettle block will consume 10 cords of mixed wood in 24 hours, or 16 cords of slabs in the same time.

Pan blocks on the Saginaw river are run almost entirely with slabs and sawdust from the saw-mills. On the lake shore mixed cord wood is the fuel used. A pan block 90 feet long and 16 feet wide, as above described, will use 14 cords of mixed wood in 24 hours, making 140 barrels of fine salt.

Steam blocks are mostly heated during the day with the exhaust from the saw-mills. This is the steam that has been made in the mill boilers. Having performed the work of running the mill engines, it is then exhausted into the pipes connected with the salt block which carry it through the settlers and graining vats and causes the evaporation of the brine. If the mill does not run at night, the boilers are connected directly with the steam pipes in the salt block and live steam is used, the fuel being the sawdust and slabs left from running the mill in the day-time.

BARRELS, MATERIAL, AND COST.

The salt barrels of Michigan are now mostly made of pine staves and heading. In some localities elm staves and ash heading are used. Most of the pine staves are made of the refuse lumber from the saw-mills. The elm stave is mostly made from stave bolts cut for that purpose.

There were manufactured into salt barrels last year, staves, heading, and hoops as follows:

Staves	53,591,760
Heading	16,077,528
Hoops	26,795,888

The barrels are mostly made by hand in cooper shops connected with salt blocks. The average cost of salt barrels is from twenty to twenty-two cents.

COOPERAGE.

Regulations in regard to Barrels.

All staves must be of such length that when the barrel is finished it shall not be less than 30½ inches or more than 31½ inches long. Soft-wood staves, whether rove or cut, to be ½ an inch thick. Hard-wood staves 7-16 of an inch thick after seasoning. Staves not more than 4 inches wide, of sound timber, and properly jointed.

Heading must be ⅝ of an inch thick, of good, sound lumber, free from holes

or unsound knots, smooth for branding. No basswood will be allowed for either staves or heading.

Hoops to be 1 inch wide and ¼ of an inch thick, 10 to each barrel, shaved and well set.

Barrels for fine salt must have heads 17½ inches in diameter. Chime to be 1 inch from point of croze. Bilge from 21 to 21½ inches in diameter outside.

Solar salt may be packed in barrels not less than 30 inches in length with a head 16½ inches. Barrels charred on the inside must be rejected.

LABOR.

The work connected with a kettle block can be accomplished by 7 men and 1 two-horse team, divided as follows: 2 boilers, 2 firemen, 1 engineer, 1 salt-packer and 1 teamster.

The capacity of pan blocks being greater than that of kettle blocks, more labor is required and is divided as follows: 4 boilers, 3 firemen, 2 engineers, 2 salt-packers and 2 or 3 teamsters.

COST OF SALT WELLS AND BLOCKS.

The expense of putting down a salt well varies, of course, according to the depth. In Saginaw county the average depth of the well is 800 feet, while down the river the average is about 1,000 feet. The average expense of sinking a well, including drill house and machinery, is about $3,000. The expense of erecting a block ranges from $8,000 to $25,000, according to capacity, and the blocks produce from 75 to 250 barrels per day.

THE EAST TAWAS AND OSCODA PIPE LINE—1881.

Mention has heretofore been made of the proposed pipe line between East Tawas and Oscoda, by which brine was to be conveyed from the former place to the latter, where the wells do not furnish a supply equal to the capacity of the works. It is now learned that George P. Smith, of the Michigan Pipe company of Bay City, has entered into a contract with Pack, Woods & Co., Oscoda Salt and Lumber company, Gratwick, Smith & Freyer, John E. Potts and John C. Gram of Oscoda, to supply them for ten years with enough brine from which at least 1,000 barrels of salt can be made daily. The pipe will be nine-inch bore of the Wyckoff patent, manufactured by the Michigan Pipe company. It is to be laid underground at a depth of three feet, and will be a great undertaking, costing in the neighborhood of $80,000. The shortest distance between East Tawas and Oscoda is 12½ miles, and the work of laying the pipe will take until August 1, providing it is commenced as soon as the frost leaves the ground. The salt rock at East Tawas is 195 feet in thickness, and its brine produces salt second to none in the State. There the wells yield on the average 200 barrels per day, while at Oscoda the yield is but about 30, so the benefit of conveying brine to Oscoda will be quickly seen.

At East Tawas will be built a pumping works, consisting of two tubular boilers, 6x16, and two powerful engines and other necessary machinery, to force the brine to Oscoda in the same manner as water is forced through the underground pipes by the Holly water-works system. The firms mentioned above intend to erect large salt works, and Oscoda's annual manufacture of salt will be increased from 80,000 barrels to over 300,000 barrels. The work of supplying Oscoda with brine will commence with five wells, which are to be enlarged from the ordinary sized three-inch tubing to that of four inches, thus greatly increasing their supply of brine.

TABLE—*Showing Companies, Amount of Salt made, Number of Kettles, Pans, Depth of Wells, for the year* 1860.

MANUFACTURERS.	Salt made 1860.	No. of Blocks.	No. of Grainers.	No. of Kettles.	No. of Pans.	No. of Covers.	No. of Wells.	Depth of Wells.	Mode of Manufacture.
HURON COUNTY.									
Thompson Bros., White Rock	40,204	2			4		3	575	Pans.
J. Jenks & Co., Sand Beach	41,339	1			6		1	702	"
Port Hope Salt Co., Port Hope	51,400	2			8		1	785	"
New River Salt Co., New River	30,255	1			3		3	1,204	"
Worthington & Sons, Grind Stone City	new	1			2		1	1,204	"
Thos. Winsor & Co., Port Austin	7,585	1	4				1		Steam.
Ayers & Co., Port Austin	35,283	1			3		1	1,198	Pan.
Williamson, Aiken & Co., Port Crescent	6,260	1	3				1		Steam.
B. Haskell, Port Crescent	new	1			2		1		Pan.
Frank Crawford, Caseville	42,575	3	8		3		5	1,760	Pan and Steam.
IOSCO COUNTY.									
Pack, Wood & Co., Oscoda	52,460	1	5				6	1,070	Steam.
Oscoda Salt & Lumber Co., East Tawas	35,277	1	5				3	1,103	"
Emery Bros., East Tawas	25,766	1	5				1	905	"
G. P. & H. B. Smith, East Tawas	18,447	2	4				1	835	Steam and Pan.
A. McBain & Son, Tawas City	6,800	1	4				1		Steam.
BAY COUNTY.									
Thos. McGraw & Co., Bay City	79,517	2	15				10	1,000	Steam.
A. Chesbrough, "	17,109	1	4				2	1,000	"
Miller & Lewis, "	65,564	2	8				5	1,050	"
S. M. Lane & Son, "	50,420	3	10				3	1,050	"
Murphy & Dorr, "	34,653	1	5				2		"
Hamilton & McGregor, "	28,135	1	4				2	1,040	"
A. Rush & Bros., "	48,172	1	5				3	1,060	"
Hay & Butman, "	25,451	1	5				2	1,036	"
N. B. Bradley & Sons, "	67,199	2	12				5	1,050	"
Wm. Peter, "	36,933	1	5				2	1,050	"
Eddy, Avery & Eddy, "	63,787	1	6				5	1,050	"
F. E. Bradley, "	36,236	1	5				2	1,050	"
Pitts & Cranage, "	58,037	1	8				4	1,000	"
Michigan Pipe Works, "	9,250	1					1	940	"
R. J. Briscoe, "	6,491	1	4				2	940	"
Folsom & Arnold, "	31,488	1	5				2	938	"
Chapin & Barber, "	40,710	1	5				3	954	"
Dolson, Chapin & Co., "	59,327	1	5				4	938	"
John McEwen, "	26,305	1	4				2	950	"
Atlantic Salt Company, "	3,000					404	1	800	Solar.
Rouse & Sons, "	7,525	1	4				1	823	Steam.
J. R. Hall, "	52,242	1	6				2	735	"
Carrier & Co., "	27,391	1	5				3		"
L. L. Hotchkiss, "	51,520	2	8				2	1,013	"
Ladirach Bros., "	820	1	4				1		"
W. H. Malone & Co., "	33,549	1	5				2	1,000	"
H. W. Sage & Co., West Bay City	68,243	1	10				6	1,020	"
Ketchem & Co.	420	1	2				1		"
Keystone L. & S. Co.	20,591	1	8				4	980	"
Montthrop & Lewis	22,458	1	5				2	840	"
P. Smith & Sons	19,148	1	5				2	830	"
SAGINAW COUNTY.									
E. Hubbell, East Saginaw	1,543	1			3		1		Pan.
Martindale Bros., East Saginaw	9,883	1	3				1		Steam.
Cook & Howard, "	2,536								Pan.
	3,626	1			3		1		"
W. A. O'Donnell, "	6,787	1			2		1		"
F. Bischke, "	4,761	1			2		1	830	"
Morey & Delano, "	9,336	1			2		1		"
Eaton, Potter & Co., Saginaw	25,800	2	6				3	823	"
J. F. & D. W. Rush & Co., East Saginaw	41,156	1	7				3	820	Steam.
Stevens & Co., "	11,643	1			2		1	820	Pan.
J. L. Remington & Co., "	30,860	1	5				3	762	Steam.
Burnham & Still, Saginaw	12,645	1	4				1	750	"
Camp & Stillman, East Saginaw	11,114	1	4				1		"
Sample & Camp, "	18,251	1	3				1	750	"
Nelson Holland, "	39,872	2	6				3	750	"
Warner & Eastman, "	29,082	1	7				2	750	"
C. & E. Ten Eyck, "	23,029	1	4				1		"
John G. Owen, "	15,550	1	6				3		"
Jesse Hoyt, "	17,260	1		120		493	3	806	"

TABLE—*Continued.*

MANUFACTURERS.	Salt made 1880.	No. of Blocks.	No. of Grainers.	No. of Kettles.	No. of Pans.	No. of Covers.	No. of Wells.	Depth of Wells.	Mode of Manufacture.
Isaac Barringer, East Saginaw	17,450	2	7	---	4	-----	4	-----	Steam and Pan.
G. V. Turner & Son, "	12,426	1	3	---	---	-----	2	950	Steam.
D. Whitney, Jr., "	65,254	1	6	---	---	-----	4	950	"
Hamilton, McLun & Co., East Saginaw	60,834	1	6	---	---	2,695	5	860	Steam and Solar.
Rush, Eaton & Co., Saginaw	24,800	1	4	---	---	-----	2	825	" "
J. F. Driggs' Sons, East Saginaw	17,215	1	----	---	3	-----	1	835	Pan.
A. T. Bliss Bros., Saginaw	80,490	3	9	---	3	-----	5	835	Steam and Pan.
Wood & Reynolds, East Saginaw	26,282	1	5	---	1	500	3	-----	Steam and Solar.
Degraw, Aymer & Co., "	29,680	1	5	---	---	-----	2	763	Steam.
La Du & Phinney, "	new	1	----	---	3	-----	1	763	Pan.
Sanborn & Bliss, "	24,138	1	5	---	---	-----	2	835	Steam.
T. Jerome & Co., Saginaw	34,498	2	3	---	2	-----	3	743	Steam and Pan.
E. F. Gould, "	20,677	1	5	---	---	-----	2	800	Steam.
James Riley, East Saginaw	23,432	1	----	---	1	-----	1	800	Pan.
Wm. B. Mershon, East Saginaw	88,083	1	2	---	--	-----	1	800	Steam.
Shaw & Williams, "	5,012	---	----	---	---	-----	---	-----	Pan.
	17,273	1	----	---	3	-----	1	800	
Jas. Perrin, "	8,400	1	3	---	---	-----	1	-----	Steam.
Kniffen Bros., "	3,581	1	----	---	2	-----	1	-----	Pan.
Chas. Merrill & Co., "	27,226	1	6	---	---	-----	3	-----	Steam.
Wylie Bros., "	29,604	1	5	---	---	-----	2	-----	"
J. H. Pearson & Son, Saginaw	28,196	1	5	---	---	-----	3	-----	"
A. W. Wright & Co., "	43,215	1	6	---	---	-----	3	741	"
Brand & Harden, "	6,812	1	2	---	---	-----	1	770	"
D. Harden & Co., "	8,921	1	2	---	---	-----	1	770	"
G. F. Williams Bros., "	34,590	2	4	---	3	-----	3	770	Steam and Pan.
N. & A. Barnard & Co., "	20,826	1	2	---	---	-----	2	830	Steam.
N. & A. Barnard, "	58,982	2	5	---	2	-----	3	830	Steam and Pan.
Saginaw Barrel Works, "	15,400	1	4	---	---	-----	2	-----	Steam.
Alex. Swift, "	36,672	2	4	---	---	-----	2	-----	"
Sturtevant, Green & Co., "	32,113	2	5	60	---	-----	3	830	"
Nason & Allen, East Saginaw	8,574	2	3	---	3	-----	1	-----	Steam and Pan.
MIDLAND COUNTY.									
Larkin & Patrick	30,080	1	5	---	---	-----	2	1,300	Steam.
J. Herrick & Co	2,361	1	----	---	---	-----	1	1,300	Pan.
W. E. Cram	1,290	1	----	---	---	-----	1	1,300	Pan.
Foster & McGill	new	1	----	---	---	-----	1	-----	Pan.
GRATIOT COUNTY.									
T. E. Holcomb, St. Louis	new	1	----	---	---	-----	1	1,256	
Total	2,676,588	121	400	180	69	4,392	228		

SYSTEM OF INSPECTION.

The irregularities that crept into the manufacture of salt, deteriorating its quality and value, soon made it evident that some system of inspection would have to be adopted to protect the careful manufacturer against the ignorance and carelessness of others.

As early as the year 1865 a system of local inspection was adopted by a number of salt manufacturers, which had a tendency to improve a portion of the salt product. The inspection, however, not being a general one, and there being no State law by which offenders could be punished, the effectiveness of the inspection was greatly diminished, and it soon became evident that some more stringent system, backed by a State law, would be the only way to secure uniformity of manufacture.

To meet this point a committee of the then existing Saginaw and Bay Salt Association was appointed in 1868 to draft a law meeting the wants of the salt manufacturers. The law as perfected by the Association was presented at the next session of the State Legislature and passed by them—approved March

6th, 1869, and amended by an Act approved April 16th, 1875. Dr. Samuel S. Garrigues received, at the hand of Gov. H. P. Baldwin, the appointment of State Salt Inspector on the 17th of March, 1869, was re-appointed by Gov. Bagley in 1875, and has just completed his second term of office, having filled for twelve years with much wisdom and fidelity a position which has enabled him greatly to advance improved methods of manufacture and to place Michigan salt on a firm footing in the market. Dr. Garrigues will in the future act as chemist to the Salt Association, and George W. Hill has been recently appointed by Gov. D. H. Jerome to act as State Salt Inspector.

AN ACT TO REGULATE THE MANUFACTURE AND PROVIDE FOR THE INSPECTION OF SALT.

SECTION 1. *The People of the State of Michigan enact*, That no salt manufactured in this State after this act takes effect shall be sold within the State, nor exported therefrom, until the same shall first be duly inspected, as provided in this act. Any person who shall violate the provisions of this section shall pay, for the use of the people of this State, as a fine, the sum of twenty cents for each bushel of salt sold or exported, contrary to the provisions of this act. In case any manufacturer of salt shall knowingly sell, or export, or permit to be sold or exported, salt, contrary to the provisions of this act, he shall, on conviction thereof, be liable to a fine not exceeding one thousand dollars, or imprisonment in the county jail not exceeding ninety days: *Provided*, That nothing in this act shall apply to any salt packed and in the hands of dealers when this act takes effect.

SEC. 2. Immediately after the expiration of the present inspector's term of office, and every two years thereafter, there shall be appointed by the governor of this State, by and with the advice and consent of the senate, an inspector of salt, who shall be a person of competent skill and ability, and who shall hold his office for two years and until his successor shall be appointed and qualified, unless sooner removed for cause. He shall at all times be subject to removal by the governor for cause; and in addition to other causes which may arise, incompetency or inefficiency in the performance of the duties devolved on him by this act, shall be deemed good cause for removal. In case of vacancy in the office, it shall be the duty of the governor to fill the same by appointment immediately upon receiving notice thereof, and such appointment shall hold until the close of the next session of the senate; and, in the meantime, the governor shall, with the consent of the senate, appoint to fill the vacancy for the unexpired portion of the term.

SEC. 3. Immediately after his appointment and qualification, the inspector shall divide the salt-making territory of this State into so many inspection districts as he may judge necessary, and shall appoint for each district one or more competent and efficient deputy inspectors, who shall hold office at the pleasure of the inspector, and for whose acts he shall be responsible. Such districts may be changed from time to time, as may be necessary. The inspector shall give his entire time, skill and attention to the duties of his office, and shall not be engaged in any other business or occupation.

SEC. 4. The inspector shall be entitled to receive an annual salary of fifteen hundred dollars. He shall also be allowed the further sum of three hundred dollars annually for the expenses of providing and furnishing his office, and for clerk hire, stationary, books, and printing. His deputies shall be entitled to such sums, in each case, as he may approve, not exceeding in any

case the sum of one hundred dollars per month for the time actually employed. All salaries and expenses provided for by this act shall be retained by the inspector out of the money received under section five of this act, and accounted for and paid out by him as provided in this act; salaries to be paid monthly: *Provided*, That in case the amount of money received for the inspection of salt, according to the provisions of section five, shall not be sufficient to pay the salaries and expenses of the inspector and his deputies, as provided herein, that the amount of such deficiency shall be deducted from said salaries *pro rata* to each.

SEC. 5. Each person, firm, company, and corporation, engaged in the manufacture of salt, or for whom any salt shall be inspected, shall from time to time, as salt is inspected or offered for inspection, pay, on demand, to the inspector, or the deputy of the district where the salt is inspected, three mills for each 280 pounds of salt inspected or offered for inspection: *Provided*, That the same may be required to be paid in advance: *And provided further*, That but one inspection fee shall be paid upon the same salt. In case any person, firm, company, or corporation shall neglect or refuse to pay such inspection fees, on demand, at his, their, or its office or manufactory, the party so refusing shall be liable to an action therefor, in the name of the inspector, and the certificate of inspection, with proof of the signature of the inspector, or deputy giving the same, shall be *prima facie* proof of the liability and the extent of the liability of the party so in default; and it shall be lawful for the inspector and his deputies to refuse to inspect salt manufactured at the works so in default until the amount due is paid. All money received by or paid to any deputy inspector under this section shall be forthwith paid to the inspector. The inspector shall keep just and true accounts of all money received under this section, and an account of the amounts received from or paid by each person, firm, company, and corporation engaged in the manufacture of salt, and all other things appertaining to the duties of the office, and the said books and accounts shall always, during office hours, be subject to the inspection and examination of any person who may wish to examine them, shall be deemed the books of the office, and shall be handed over to his successor in office, together with all the money and effects appertaining to the office.

SEC. 6. The inspector shall, before entering upon the duties of his office, take the oath prescribed by the constitution of this State, which oath shall be filed in the office of the Secretary of State. He shall also execute a bond to the people of this State, in the penal sum of seven thousand dollars, conditioned for the faithful performance of the duties of his office, which bond shall have at least two sureties, and shall be subject to the approval of the State Treasurer, and when approved shall be by such treasurer filed and deposited in his office; and the inspector shall renew his bond every year. Any person or corporation injured by the neglect or default of such inspector, or by his misfeasance in office, or by the neglect, default, or misfeasance of any of his deputies, may maintain an action on such bond, in the name of the people, for the use of the party prosecuting, and shall be entitled to recover the full amount of damages sustained.

SEC. 7. Each of the deputies appointed by the inspector shall take the oath of office prescribed by the constitution, and shall give bond to the inspector in such sum, and with such sureties as he may approve, conditioned for the faithful performance of his duties as such deputy; and in case said inspector shall be obliged to pay any sum for the neglect or default or misfeasance of any

deputy, he may recover of such deputy and his sureties on such bond the amount he was obliged to pay, with accruing costs.

SEC. 8. The inspector shall keep his principal office in either Saginaw or Bay county, and the deputy for the district in which such office is located may occupy the same office. This office shall be kept open at all times during business hours. All the books, records, and accounts, shall be kept at this office, and each deputy shall, at least once in each week, make written report, by mail or otherwise, to the inspector, of the salt inspected by him during the week, stating for whom, and the quality and quantity thereof. Abstracts of these reports shall be entered in books provided for that purpose. Said inspector shall, in proper books, keep a full record and account of all his transactions; and such books shall also be open for the examination of all persons wishing to examine the same during office hours.

SEC. 9. The inspector shall not be in any way concerned in the manufacturing or selling of salt, or have any interest whatever, directly or indirectly, in any salt manufactory or erection for manufacturing salt in the State of Michigan, or in the profits of any such manufactory.

SEC. 10. It shall be the duty of the deputy, in each district, to visit, once in each day, Sundays excepted, each salt manufactory in his district, when in operation, and to ascertain if there be therein any salt of bad quality, and such as ought not to pass inspection.

SEC. 11. It shall be the duty of the inspector in person to visit the manufactories in which salt is made, that may be in operation, in the different districts, as often as practicable.

SEC. 12. The inspector or deputy, at each visit, as provided in this act, shall carefully examine the salt in the bins, and the brine in kettles, or pans, or vats, in which the salt is manufactured. If the salt in the bins or any part thereof is of bad quality and such as ought not to pass inspection, or if the brine in the kettles, or pans, or graining vats, has not been cleansed, he will direct and see that the owner, or occupant, or boiler, or other person having charge of the manufactory, remove the bad salt from the bin and place it with second-quality salt, or throw it among the bitterns, as the inspector or deputy may direct, and that the impure brine in the kettles, or pans, or graining vats, be thrown out, and new brine substituted.

SEC. 13. No lime nor lime-water shall be used by any person in the manufacture of salt, in the kettles or pans, or graining vats, used for manufacturing, under a penalty of twenty-five dollars and costs for each offense, to be sued for in the name of the people of this State; *Provided*, That iron vessels used in the manufacture of salt may be whitewashed, when cool, to prevent the accumulation of rust.

SEC. 14. Every person desiring to have salt inspected shall apply to the inspector or deputy inspector of the district where the same shall be, which inspector or deputy inspector shall thereupon actually examine the salt so offered for inspection, in the package in which the same may then be.

SEC. 15. To facilitate such examination, it shall be the duty of the person or company offering the salt for inspection to unhead or bore the barrel, or to open the bag or other package in which the salt is contained, as may be directed by the inspector or deputy inspector, so as to expose the salt to his touch, view, and examination.

SEC. 16. The inspector or deputy inspector shall not pass any salt as good unless he shall find it to be well made, free from dirt, filth and stones, and from admixture of lime, or ashes of wood, and of any other substance which is in-

jurious to salt, fully drained from pickle, the bitterns properly extracted therefrom, and manufactured as directed by this act and by the rules and regulations of the inspector.

SEC. 17. The person or company offering the same for inspection shall in all cases provide the necessary force to lift the salt while the inspector or deputy weighs or measures it, and shall also furnish the necessary help and material to brand the salt for and under the direction of the inspector or deputy inspector.

SEC. 18. Each manufacturer shall provide a scale or balance at his works, to be examined from time to time, and approved by the inspector, in which all the salt offered for inspection at his works may be weighed.

SEC. 19. Each inspector or deputy shall deliver to the party for whom he shall inspect salt, a certificate of the quantity and quality inspected, and shall thereupon direct the employes of the manufacturer to brand or mark, under his personal supervision, with durable paint, the package containing the salt so inspected, with the surname of the inspector at length and the initials of his Christian name, with addition of the word inspector, in letters at least one inch in length, and shall also cause to be marked or branded by the employes of the manufacturer, upon the head of the barrel, cask, or package, the weight prescribed for such barrel, cask, or package by the inspector, when such weights are in conformity to the rules and regulations prescribed by the inspector in that regard; and if such weights do not correspond to the rules and regulations, he shall cause the same to be repacked so as to conform thereto.

SEC. 20. If the said salt shall be put up in barrels, it shall not be marked unless the barrels are thoroughly seasoned, stout, and well made, with such number of hoops as shall be prescribed by the inspector, to be well nailed and secured.

SEC. 21. Every person who shall falsely or fraudulently make or counterfeit, or cause to be made or counterfeited, or knowingly aid and assist the false or fraudulent making or counterfeiting the mark or brand of any inspector or deputy inspector, on any package containing salt, shall be deemed guilty of felony, and on conviction thereof shall be subject to a fine of not less than one hundred nor more than one thousand dollars, or be imprisoned in the State prison for a term not less than one nor more than six years, or both, in the discretion of the court.

SEC. 22. No manufacturer or other person shall pack, or cause to be packed, in barrels, casks, boxes, or sacks, any salt, until an inspector shall have determined, upon actual examination, that the same is sufficiently drained of pickle, and otherwise fit to pack.

SEC. 23. The inspector and his deputies, in their daily examination of the several salt manufactories, shall examine all bins of salt, for the purpose of ascertaining whether any salt is packed contrary to the provisions of the last foregoing section.

SEC. 24. If any manufacturer or other person shall pack any salt before the inspector or one of his deputies shall have determined that it is fit for packing, he shall forfeit the sum of twenty-five cents for every bushel of salt so packed.

SEC. 25. Barrels, casks, or sacks in which salt shall have been packed and inspected shall not again be used for the packing of salt therein until the marks or brands made by the inspector shall be first cut out or removed; and if any person shall pack, or cause to be packed, or shall aid or assist in packing, any uninspected salt in any such barrels, casks, or sacks, without first cutting out or removing such marks or brands, he shall forfeit, for every bushel of salt so packed, the sum of one dollar.

SEC. 26. It shall be the duty of every manufacturer to brand or mark with durable paint every cask or barrel of salt manufactured by him, with the surname at full length of the proprietor or owner of the manufactory at which the same shall have been made, and the initial letters of his Christian name, and if the same shall have been manufactured for a company or association of individuals, he shall mark or brand, in like manner, upon every such cask or barrel, the name by which the company is usually called: *Provided*, That no second-quality salt shall be so marked.

SEC. 27. No inspector or deputy inspector shall inspect or pass any barrel, cask, box, or sack of salt which shall not be marked or branded in the manner prescribed in the last section, and the inspector or deputy shall not affix his brand to any barrel of salt which shall not have been so branded by the manufacturer offering the same for inspection: *Provided*, That none of the provisions of this section shall apply to second-quality salt: *And provided further*, That the inspector may, by regulations prescribed by him, provide that both the brand of the manufacturer and that of the inspector shall be put upon each package at the same time.

SEC. 28. Salt of an inferior quality—dirty, damaged, or condemned—may be sold loose, or in bulk, by the manufacturer thereof, at the works, the inspector making bills of the same, designating the quantity by weight, as in ordinary cases, and distinguishing the same as "second quality;" or such inferior salt may be packed in barrels, boxes, casks, or sacks, and branded by the inspector with the words "second-quality salt," in plain letters not less than one inch in length, and such inspector shall add the initials of his name, and no other or different brand shall be placed thereon; and said second-quality salt, subject to the provisions of this section, may be sold or exported by the owner as such.

SEC. 29. Every person who shall forge or counterfeit the name so required to be put on by the manufacturer, or shall cause or procure to be put on any barrel or cask in which salt shall be packed the name of any person other than that which properly should be placed thereon, according to the provisions of this act, shall, for every such barrel, cask, or sack, forfeit the sum of one hundred dollars, and shall also be liable for all damages to the party aggrieved.

SEC. 30. The inspector shall, by regulation, from time to time, specify the quantity of salt that shall be contained in bags or other packages which shall be offered for inspection; and it shall not be lawful for him to authorize the inspector's brand to be placed upon any package that does not correspond with said regulation.

SEC. 31. The inspector shall, by regulation, require that all ground salt manufactured and put up for the market shall be legibly marked on each keg, box, sack, bag, or other package containing the same, with the words "ground solar," or "ground boiled," or "ground steam," or "ground Chapin," as the fact may be; such marking to be done in letters of not less than an inch in length.

SEC. 32. If the inspector shall consent to, connive at, aid or abet, the smuggling of salt, or the transportation of the same away, so as to evade the inspection thereof, or shall accept of any bribe, or sum of money, or any gift or reward whatsoever, upon any express or secret or implied trust, or confidence that he shall connive at, or consent to any evasion of the laws for the inspection of salt, such inspector shall forfeit his office and pay to the use of the people of this State the sum of one thousand dollars.

SEC. 33. If any deputy inspector shall be guilty of the offenses specified in the last section, or any of them, the inspector appointing such deputy shall

forfeit to the use of the people of this State the sum of two hundred and fifty dollars, for the recovery of which his bond shall be put in suit.

SEC. 34. The inspector and each of his deputies shall be exempt from serving on juries, and from all military service, except in case of actual invasion or insurrection; and the commission or appointment in writing of any such officer or deputy shall be evidence of the facts stated therein.

SEC. 35. The inspector shall have power, from time to time, to make and ordain such necessary rules and regulations as he may deem expedient, concerning:

First, The manufacturing and inspection of salt not inconsistent with the provisions of this act;

Second, The daily examination, and the reporting by his deputies, of the operation and extent of the several salt manufactories, so as to determine whether the quantity of salt inspected at each manufactory is equal to the quantity actually manufactured thereat;

Third, The districting of the salt-making territory in this State, and the duties of his deputies under this act, and he may alter and revoke such rules and regulations at his pleasure.

SEC. 36. The inspector shall have power to annex penalties, not exceeding ten dollars in any case, to the violation of such rules and regulations. Such rules and regulations shall be printed and posted up in the office of the inspector, and in each manufactory, and published at least once in some newspaper in each county where salt is manufactured, and shall, after they have been posted and published as aforesaid for one week, be binding upon all persons concerned.

SEC. 37. It shall be the duty of the inspector and of his deputies, upon being applied to by any manufacturer to inspect salt in his district, to inspect the same forthwith; and in no case shall the inspector or any deputy delay the inspection of salt beyond twelve hours of daylight, excluding Sundays, after such application, unless such manufacturer shall consent to the delay. For a violation of this section by the inspector, or any one of his deputies, the inspector and his sureties shall be liable to the party aggrieved in the sum of fifty dollars over and beyond all actual damages sustained.

SEC. 38. Nothing contained in this act shall be construed so as to prevent the sale or exportation of the bitterns from any manufactory of salt, such bitterns to be sold or exported in bulk, or if in casks or barrels, to be branded as bitterns, and sold or exported as such.

SEC. 39. In case of any vacancy, from any cause, in the office of the inspector, the deputy who has been longest continuously in office shall possess the powers and perform the duties of inspector until such vacancy shall be filled; and the bond of the inspector and his sureties shall continue to be liable for the acts of all the deputies, until such vacancy shall be filled.

SEC. 40. The inspector shall annually, in the month of December, and on or before the fifteenth day thereof, make a report to the Governor of this State, which shall contain:

First, The number of districts into which the salt-producing territory of this State may then be divided, with the name and locality of each, and the number and capacity of the works of each district;

Second, The quantity and quality of salt inspected in each district during the preceding year;

Third, The amount received and expenses incurred under this act for the preceding year, in detail;

Fourth, Such suggestions and recommendations as he may think proper to make concerning the manufacture of salt, and the operation of the inspection laws upon the same, and as to what further legislation on the subject, if any, would be advisable. A copy of such report shall be published immediately after its date, in some newspaper in the Saginaw valley.

SEC. 41. The inspector shall establish a grade of "fine" salt, the grain of which shall be at least as fine as the average grain of salt made in kettles. He shall cause the word "fine" to be marked on the packages containing such salt, in large letters, and the word "fine," with or without qualification, shall not, under any circumstances, be placed on salt of coarse grain; but all other grades shall be designated on the packages by some truly descriptive mark or brand, and the inspector may mark salt "second quality" for imperfect grain, as well as for any other defect.

SEC. 42. Nothing in this act contained shall be construed to prevent the sale or shipment of salt in bulk, after the same shall have been duly inspected and a certificate thereof given by said inspector or any deputy; and nothing in this act shall be construed to prevent manufacturers from putting such private trade-mark or brand on their salt as they may see fit: *Provided*, It contains no untruth or statement calculated or intended to deceive the purchaser.

SEC. 43. In case the inspector shall, at the time of making any annual report, have a surplus of money arising from the inspection fees, in this act provided for, in his hands, he shall apportion back and pay such surplus to the persons, firms, or corporations for whom salt has been inspected during the last preceding year, in proportion to the amounts paid by them respectively for inspection fees.

RULES AND REGULATIONS ORDAINED BY STATE INSPECTOR OF SALT.

1. *It is hereby ordained*, That, in the manufacture of salt by fire heat, the brine when received into the cistern shall remain at least forty-eight hours after the first plunging before it shall be drawn thence into the kettles or pans. The use of lime or any other substance in the manufacture of salt, by being mixed with or added to the water in any stage of the process, without permission of the inspector, is hereby expressly forbidden.

2. The cisterns of each block shall be thoroughly cleansed at the opening of the manufacturing season, and as often and whenever it may be required afterward by the inspector, and it is required that each block shall have at least four cisterns of the ordinary capacity.

3. The connections by which water shall be drawn from the cisterns into the blocks shall be inserted so as to receive the water at least six inches above the bottom of the cisterns.

4. Each manufacturer shall provide a good basket, of sufficient capacity to hold one entire drawing for each kettle in operation, into which the salt shall be drawn and there remain over the kettle for thorough drainage before being discharged into the bin, and the basket shall be well cleansed before being replaced over the kettle, and such salt shall remain in full view until the inspector, in his daily examination, shall have an opportunity to see it before it is broken to pieces.

5. The bins shall be kept clean and no salt put therein except such as is of first quality. After a bin has been emptied, it shall be washed out and so cleansed that the opening in it shall admit of the proper drainage of the salt. The floor of all salt-houses shall be raised at least six inches from the ground to allow drainage, and there shall be a sufficient number of bins attached to

each block, of convenient size, for storage of all the salt which may be made at such block while it is undergoing the process of drainage.

6. All salt shall stand in the bins at least fourteen days before packing, and the term will be taken to commence from the last discharge of wet salt into the bin. Salt in the bins shall be leveled off evenly at the top and so kept; nor will the packing of any such salt be allowed until the same has been declared fit for that purpose, upon actual examination by the inspector; and the packing of any salt without express permission, although fourteen days may have expired, will not be allowed.

7. Whenever it shall be found that salt has been pickled, or otherwise packed in a wet condition, so that the barrels will drain, it will have to be emptied again, and the persons packing such salt will be held liable to a penalty of ten dollars for each and every offense.

8. It is hereby declared unlawful for any manufacturer, boiler, or packer of salt, or any other person by their permission or procurement, to throw water upon or otherwise wet any salt in the bin or in the barrel before, whilst, or after packing the same; and the same is expressly forbidden. Any person so offending shall forfeit and pay a fine of ten dollars for each and every offense. Nor shall any such person discharge any wet salt into the bins or upon salt previously deposited therein, under a penalty of ten dollars.

9. Salt of an inferior quality that has been condemned by the inspector may be sold in bulk as "second quality," and if packed must be branded in large letters "second quality," payment of dues being made in the usual manner. Every manufacturer of salt shall be provided with a suitable place of deposit for "second quality" and "refuse" salt, where the same shall be discharged and shall remain subject to the observation of the inspector; and such inferior salt shall not be mixed with nor sold as best salt. Whenever required by the inspector, the person in charge of a manufactory shall cause any wet or inferior salt to be removed to the place of deposit for such salt, or, at his option, and in his presence, may return the same to the cisterns to be dissolved.

10. The quantity that may be packed in each barrel shall be 280 lbs. of salt. Solar, ground, dairy, and table salt may be packed in quantities of 280 or 320 lbs., at the option of the manufacturer, and the latter qualities, if intended for market, in sacks, may be packed in barrels, in sacks, or put in barrels with the empty sacks. The tare of barrels is fixed at 22 lbs. for staves of soft and 25 lbs. for staves of hard wood.

11. Each packer shall make a hole $\frac{7}{8}$ inch in diameter in one head of each barrel packed, for the convenience of the inspector, and shall aid the inspector at all times in weighing the packages of salt.

12. All ground salt manufactured and put up for the market shall be legibly marked on each keg, box, sack, bag, or other package containing the same, with the words "ground solar," "ground steam," as the fact may be, such marking to be done in letters.

13. The average grain of salt boiled in kettles shall be the standard of "fine salt," and shall be branded as such. All salt coarser than the average grain of kettle salt manufactured by Chapin, steam, pan, or other process, shall be branded "packers," and the coarsest salt made by same processes shall be branded "C packers' C." Solar salt shall be branded "solar," and if screened the two qualities shall be designated "C solar C" for coarse, and "F solar F" for finer. No salt shall have these brands unless of first quality, of its respective grain in all respects. Salt discolored in the manufacture or from any cause not of first quality shall be branded "second quality" in letters two inches in

length, and have no other inspection-mark. But the manufacturer may work all such salt over again if preferred. Lower grades of salt may be put in old barrels, and shall be branded "refuse" without other marks.

14. Every manufacturer shall keep his premises used for the storage of salt in packages in a neat and clean condition, so that salt, while awaiting inspection or shipment, shall not be liable to be rendered wet or dirty, and shall keep the same protected from the weather; and all salt not kept in a state of preservation, and neatly and carefully packed in tiers not more than three barrels high, so as to remain in sound, merchantable condition, after the same has been inspected and branded, shall be repacked or otherwise disposed of according to its quality.

15. For any neglect or refusal to comply with either or any of the foregoing rules or regulations, or for any evasion or violation of the same, on the part of the manufacturers of fine or steam salt, or any person or persons in their employ, a penalty of ten dollars is hereby imposed, to be paid to the inspector or his deputies, on demand or record in a court of justice, with costs as provided by law. All the reulations shall be held to apply to the manufacturer of salt by other processes than boiling in kettles.

19. All salt finer than the average grain of fine salt may be branded "dairy salt," if found to be of sufficient purity, after having been submitted to a chemical analysis, otherwise no salt shall be branded "dairy salt."

SALT DISTRICTS.

The salt-producing territory of Michigan was divided by the State Inspector of Salt into nine inspection districts, as follows:

District No. 1, East Saginaw and Buena Vista.
" " 2, Saginaw City and Garfield.
" " 3, Carrollton and Zilwaukie.
" " 4, Bay City and Salzburg.
" " 5, Bay City and West Bay City.
" " 6, Caseville, Port Crescent, Port Austin, Grindstone City, and Port Hope, Huron county.
" " 7, Sand Beach and White Rock, Huron county.
" " 8, Oscoda, East Tawas, and Tawas City, Iosco county.
" " 9, Midland, Midland county.

In the above named districts there were, in the year 1880, in operation 3 kettle, 31 pan, and 85 steam blocks, making a total of 119 blocks.

From the estimate given, the manufacturing capacity of the entire State amounts to 3,150,000 barrels, or 15,750,000 bushels of salt. This shows an increase over last year's production of about 500,000 barrels or 2,500,000 bushels of salt.

AMOUNT OF SALT INSPECTED IN 1880.

The following gives the amount of salt inspected in the respective inspection districts:

District No. 1, East Saginaw and Buena Vista; George W. Hill, inspector.

	Bbls.
Fine salt	422,877
Packers' salt	152
Salar salt	10,260
Second quality salt	7,423
Total	440,712

District No. 2, Saginaw City and Garfield; V. W. Paine, inspector.

	Bbls.
Fine salt	234,419
Packers' salt	592
Second quality	1,667
Total	236,678

District No. 3, Carrollton and Zilwaukie; James Hill, inspector.

	Bbls.
Fine salt	452,829
Packers' salt	4,260
Solar salt	8,777
Second quality	8,579
Total	474,385

District No. 4, Bay City and Salzburg; Wm. R. McCormick, inspector.

	Bbls.
Fine salt	531,748
Packers' salt	1,504
Second quality	4,957
Total	538,209

District No. 5, Bay City and West Bay City; W. R. Wands, inspector.

	Bbls.
Fine salt	532,137
Packers' salt	1,765
Solar salt	3,200
Second quality salt	6,530
Total	543,632

District No. 6, Caseville, Port Crescent, Port Austin, New River, Port Hope, Huron county; H. Adams, inspector.

	Bbls.
Fine salt	207,380
Packers' salt	3,987
Second quality	4,012
Total	215,379

District No. 7, Sand Beach and White Rock, Huron county; J. McMuldraeh, inspector (deceased).

	Bbls.
Fine salt	39,910
Packers' salt	291
Second quality	1,261
Total	41,462

District No. 8, Oscoda, East Tawas and Tawas City, Iosco county; C. W. Gabrille, inspector.

	Bbls.
Fine salt	139,076
Packers' salt	3,729
Second quality salt	6,905
Total	149,800

District No. 9, Midland, Midland county; Joseph Wood, inspector.

	Bbls.
Fine salt	27,873
Packers' salt	410
Second quality salt	8,048
Total	36,331

The total amount of salt inspected for 1880, is as follows:

	Bbls.
Fine salt	2,589,037
Packers' salt	16,691
Solar salt	22,237
Second quality salt	48,623
Total	2,676,588

This will make 13,382,940 bushels of salt, being an increase of 3,092,742 bushels, or 620,748 barrels, over last year's production.

Of the total amount inspected in the State, there was inspected in

	Bbls.
Bay county	1,081,841
Saginaw county	1,148,644
Huron county	256,841
Iosco county	147,800
Midland county	41,462
Total	2,676,588

The following table will show the amount of the various grades of salt inspected in Michigan since 1869, the first year of the establishment of the State salt inspection:

Salt.	1869. Bbls.	1870. Bbls.	1871. Bbls.	1872. Bbls.	1873. Bbls.	1874. Bbls.
Fine	513,989	568,326	655,923	672,034	746,702	960,757
Packers'	12,918	17,869	14,677	11,110	23,671	20,090
Solar	15,264	15,507	37,645	21,461	32,267	29,391
Second quality	19,117	19,650	19,930	19,876	20,706	16,741
Total	560,888	621,352	728,175	724,481	823,346	1,026,976

Salt.	1875. Bbls.	1876. Bbls.	1877. Bbls.	1878. Bbls.	1879. Bbls.	1880. Bbls.
Fine	1,627,886	1,402,410	1,590,841	1,770,361	1,997,350	2,589,037
Packers'	10,233	14,233	20,389	19,367	15,641	16,691
Solar	24,336	24,418	22,949	33,541	18,020	22,237
Second quality	19,410	21,668	26,818	32,615	27,029	48,623
Total	1,081,865	1,462,729	1,660,997	1,855,884	2,058,040	2,676,588

CARE IN GRADING SALT.

It is well known to all interested that the standard of Michigan salt has for some years past been very high, and at the same time very reliable, and these facts have had very much to do with its steady increase in popularity and ready sale. To their credit, the Saginaw *Herald* says, most of the manufacturers have cheerfully seconded the efforts of the State Salt Inspector and the Salt Association to make a pure, even and reliable article and grade; but a few have failed to see the prime importance of this, and have, with obstinacy, resisted all attempts to interfere with their limited and erroneous ideas of mixing grades, and have thereby caused themselves trouble, and have injured the reputation of our salt in the general market. The manufacturers should understand

that great care should be taken in selecting and assorting the product of their pans and grainers, especially, much more so than in the old kettle process, when the product of each kettle could be kept separated. It not unfrequently happens that different degrees of heat and exposure will produce different qualities of grain in the same pan, and the proper separation of the product into a proper grade requires care and judgment. This trouble is becoming so extensive that Dr. Garrigues has at last felt compelled to call attention to it and has issued the following circular:

OFFICE OF THE STATE SALT INSPECTOR,
EAST SAGINAW, Mich.

To the Salt Manufacturers of Michigan:

Your attention is respectfully called to the new construction of the following section of the State inspection law:

In accordance therewith, the deputy salt inspectors are required to brand all salt not strictly fine or not strictly packers' as second quality.

SECTION 41. The inspector shall establish a grade of "fine" salt, the grain of which shall be at least as fine as the average grain of salt made in kettles. He shall cause the word "fine" to be marked on packages containing such salt in large letters, and the word "fine," with or without qualifications, shall not, under any circumstances, be placed on salt of coarse grain; but all other grades shall be designated on the packages by some truly descriptive mark or brand, and the inspector may mark salt "second quality" for imperfect grain, as well as for any other defect.

Yours respectfully,

SAMUEL S. GARRIGUES,
State Inspector of Salt.

PRODUCTION DURING THE HISTORY OF SALT MANUFACTURE IN THE STATE.

The salt manufacture in this State commenced in 1860, and the inspection law was not enacted until 1869. Previous to the inspection law the annual product was as follows:

	Bbls.
1860	4,000
1861	125,000
1862	243,000
1863	466,356
1864	529,073
1865	477,200
1866	407,077
1867	474,721
1868	555,690

The product since 1869, at which time the inspection law took effect, is as follows:

	Bbls.
1869	560,818
1870	621,350
1871	728,175
1872	724,481
1873	823,346
1874	1,028,979
1875	1,081,865
1876	1,462,729
1877	1,960,997
1878	1,855,884
1879	2,058,040
1880	2,676,588

The only competitor in salt manufacturing of magnitude is the Onondaga works in New York, and a comparison of the Michigan product with that of Onondaga in bushels, makes a showing about as follows:

MICHIGAN SALT.

	Bushels.
1877	8,303,985
1878	9,269,545
1879	10,390,200
1880	13,382,940

ONONDAGA.

	Bushels.
1877	6,427,983
1878	7,176,197
1879	7,934,854
1880	8,481,473

It will be observed that Saginaw leads Onondaga largely in the product, and is to-day the largest salt-producing district in the United States.

PRICES, MARKETS, PROSPECTS.

The average price obtained for the Saginaw product during a series of years shows as follows:

Average price per barrel, 1866	$1 80
" " " " 1867	1 77
" " " " 1868	1 85
" " " " 1869	1 58
" " " " 1870	1 32
" " " " 1871	1 46
" " " " 1872	1 46
" " " " 1873	1 37
" " " " 1874	1 19
" " " " 1875	1 10
" " " " 1876	1 05
" " " " 1877	85
" " " " 1878	85
" " " " 1879	1 02
" " " " 1880	75

The bulk of the salt handled by the association goes to Chicago, but it has distributing points also at Milwaukee, Racine, Duluth, Toledo, Sandusky, Cleveland, Dunkirk, Erie, St. Louis, Cincinnati and Hannibal, Mo. The association has shipped largely by both water and rail, the movement by the latter method having largely increased during the past year. The amount shipped by the association during the year has not as yet been definitely ascertained, but will probably reach 2,100,000 barrels.

COLLATERAL PRODUCTS OF MICHIGAN BRINES.

As shown by the chemical analyses, Michigan brines contain, besides salt, percentages of chloride of calcium, chloride of magnesium, and bromide of magnesium.

Chloride of calcium, which forms the largest proportion of the waste mother liquors, after the salt has been extracted from the brine, is now having a value

for various purposes. Its concentrated solution is used as a bath in the putting up of canned fruit. It is also employed in the manufacture of chloride of barium and artificial sulphate of baryta. In some localities it has also found very extensive use in the manufacture of artificial stones by the Ransom patent.

Bromine contained in the brines, as a bromide of magnesium, is now being extensively produced from the refuse bitter waters of the salt manufacture. Bromine is largely used in the arts and pharmacy. The annual American product of bromine is now over 130,000 pounds.

MICHIGAN SALT ASSOCIATION.

The Michigan Salt Association was organized in 1876, and embraces as members all the manufacturers in the State excepting 13. The principal office of the association is at East Saginaw. The capital stock of the association is $200,000, and its object is to secure unity of action and stability of price. The association handles the product of the manufacturers, taking their salt as fast as made, making liberal advance thereon, placing it in the market and paying for it in full when sold. It has agencies at all the leading distributing points for the product. The price of Michigan salt is fixed by the association, which comes far nearer effecting that unity among manufacturers than did any previously attempted combination, and the salt business of Michigan has been immensely benefited through the sagacious management of the officers of the association. The present officers are:

President—Wellington R. Burt.

Vice President—Albert Miller.

Treasurer—Thomas Cranage, Jr.

Secretary—D. G. Holland.

Executive Committee—W. R. Burt, J. L. Dolson, T. Cranage, Jr., N. Barnard, W. J. Bartow.

Directors—W. R. Burt, W. J. Bartow, Ezra Rust, H. A. Bachelor, J. R. Hall, N. B. Bradley, Thomas Cranage, Jr., J. L. Dolson, H. W. Sage, W. R. Stafford, E. F. Holmes, G. F. Williams, James Ayres and J. L. Remington.

The association expires by limitation in March, 1881, and as an evidence of the benefits it has conferred, at a recent preliminary meeting of the stockholders in this city, it was voted unanimously to continue the organization under the title of the Salt Association of Michigan.

The Michigan Dairy Salt Company, of East Saginaw, Michigan, organized April 28th, 1877, W. R. Burt, president, and W. J. Bartow, secretary and treasurer, has been in active and successful operation continuously since, producing the highest grade of dairy and table salt known to the trade. Present managers, J. A. Hamilton, president, and W. J. Bartow, secretary and treasurer.

CAPACITY OF SALT MANUFACTURE.

The capacity of the several firms for manufacturing, based on the production of the past year, ranges from about 5,000 to 80,000 barrels each. The firm of T. H. McGraw & Co., at South Bay City, it is said, have facilities perfected for manufacturing 10,000 barrels per month. The firm of A. T. Bliss & Bro., at Zilwaukie, have manufactured during the past year about 80,000 barrels. The largest production in the aggregate during any one month since the commencement of salt manufacture in this State was in August last, when the product reached 301,291 barrels. The lowest monthly production during the inspection year of 1880, ending November 30, was 171,917 barrels, and the highest, as stated, 310,291 barrels. It is estimated that the product of the inspection year